IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor	:	Steven Bathiche et al.	
Appln. No.	:	09/251,519	
Filed	:	February 17, 1999	Group Art Unit: 2675
For	:	TWO-HANDED COMPUTER INPUT DEVICE WITH ORIENTATION SENSOR	Examiner: S. Kumar
Docket No.	:	M61.12-0101	

SUPPLEMENTAL BRIEF FOR APPELLANT

I HEREBY CERTIFY THAT THIS PAPER IS BEING SENT BY U.S. MAIL, FIRST CLASS, TO THE ASSISTANT COMMISSIONER OF PATENTS, WASHINGTON, D.C. 20231, THIS

31st DAY OF December, 2003.

[signature]
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Sir:

This is an appeal from a rejection of the claims in an Office Action dated October 6, 2003, which re-opened prosecution following an earlier appeal. This Supplemental Brief is being submitted with a request for reinstatement of the appeal under M.P.E.P § 1208.02.

REAL PARTY INTEREST

Microsoft Corporation, a corporation organized under the laws of the state of Washington, and having offices at One Microsoft Way, Redmond, Washington 98052, has acquired the entire right, title and interest in and to the invention, the application, and any and all patents to be obtained therefor, as set forth in the Assignment filed with the patent application and recorded on Reel 010056, frame 0039.

RELATED APPEALS AND INTERFERENCES

There are no known related appeals or interferences which will directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

STATUS OF THE CLAIMS

Claims 1-20, 22 and 23 are pending in the application (see Appendix A). Claims 1-20, 22 and 23 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Ogata (U.S. Pat. No. 6,001,014) in view of Barnes et al. (U.S. Pat. No. 6,069,594). Claim 21 has been canceled.

STATUS OF AMENDMENTS

There are no outstanding amendments.

SUMMARY OF INVENTION

The present invention generally relates to a computer input device. In particular, the present invention relates to a computer input device having an orientation sensor disposed thereon.

Various embodiments of the present invention pertain to the computer input device 14, generally described on page 5, line 27 to page 7, line 12. Fig. 1 illustrates an exemplary computer input device 14 for use with embodiments of the present invention. Input device 14 includes one or more orientation sensors arranged to sense the physical orientation of the computer input device 14 in space. Furthermore, the computer input device 14 includes rotatable wheel 24, multiple switch input device 26, shift button 28, mode switch button 30, one or more auxiliary buttons 32 and one or more triggers (Fig. 3A). The input device further includes an upper housing portion with two depending handles 17 and 19.

As schematically illustrated in Fig. 4, the computer input device 14 also includes a controller 106. Operation of controller 106 and the input device 14 as described on page 14, line 9 to page 19, line 30. Controller 106 is configured to receive signals from X and Y axis tilt sensors and circuitry 108, button array 112, zone calibration circuit 114 and wheel encoder circuit 116 through elements disposed on computer input device 14. Furthermore, controller 106 outputs a mode indicator 118.

Controller 106 also is configured to assemble data packet 122 in order to be sent to computer 20.

Various aspects of the present invention include a method of generating a data packet indicative of user operation of the computer input device 14. An exemplary data packet 122 is illustrated in Fig. 5 and described on page 19, line 31 to page 22, line 3. A related method is illustrated in Fig. 6 and includes steps described from p. 22, line 4 to page 26, line 31. Information indicative of a physical orientation of the input device is received at step 124. In addition, information indicative of a multiple switch device or a rotatable member is received at 126. Further, the orientation data and at least one of the multiple switch device information or rotatable member information is assembled into a data packet at either 134 or 146. Another aspect of the invention pertains to a data structure generated as described above.

Computer device 14 enables a number of different input modes to be used, if desired. These modes may be used to control a visual display 16. In one mode, orientation information is used to control display 16 and in another mode multiple switch information is used to control the display 16. Data packet 122 is assembled in such a manner that an application need not know the mode in which computer input device 14 is operating. The application can simply examine the X and Y tilt information fields and use the information accordingly. This feature saves programmers time in developing applications that utilize input device 14.

DESCRIPTION OF REFERENCES RELIED ON BY THE EXAMINER

Ogata et al.(U.S. Pat. No. 6,001,014)

Ogata et al.(see Appendix B - Exhibit A) discloses a game machine control module 1 connected to a game machine 27. The control module transmits operational data obtained by a plurality of buttons to the game machine and receives dynamic transmission

data from the game machine. The dynamic transmission data controls a vibrator member 21 in the control module. The control module also includes a plurality of angular velocity sensors 155.

Barnes et al. (U.S. Pat. No. 6,069,594)

Barnes et al. (see Appendix B - Exhibit B) discloses a computer input device 30 that includes microphones 31, 32 and 33 for receiving acoustic signals from a reference frame 20. The input device 30 provides positional information in a Cartesian coordinate system as well as rotation about the X, Y and Z axes. Keys 36 are provided that operate independent of each other.

ISSUES

Whether claims 1-20, 22 and 23 are obvious under 35 U.S.C. 103(a) over Ogata et al. in view of Barnes et al.

GROUPING OF CLAIMS

The following groupings of claims are made solely in the interest of consolidating issues and expediting this Appeal. No grouping of claims is intended to be nor should be interpreted as being any form of admission or a statement as to the scope or obviousness of any limitation.

Group I : Claims 1, 10, 16, 20;
Group II : Claims 2, 7-9, 23;
Group III : Claims 3-6, 22;
Group IV : Claims 11, 12; and
Group V : Claim 13-15, 17-19.

ARGUMENT

Rejection of Group I Claims

Claims 1, 10, 16 and 20 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Ogata et al. in view of Barnes et al. Appellant submits that this combination fails to render the Group I claims obvious.

Claim 1 is an independent claim and recites a method of preparing a data packet indicative of operator manipulation of a handheld computer input device. Independent claim 16 recites a data structure generated by a computer input device for transmission to a computer. Independent claim 20 is directed towards a computer input device. Claim 10, which depends on claim 1, recites further limitations to the step of placing data in the orientation field and multiple-switch field in the data packet. Detailed descriptions of the methods and apparatuses of claims 1, 10, 16 and 20 are described in the Appeal Brief filed July 8, 2003 in Groups I, V, X and XIII.

In order to establish a prima facie case of obviousness, three basic criteria must be established by the Examiner. First, there must be some suggestion or motivation to combine the references. Next, there must be a reasonable expectation of success. Finally, the prior art references must teach or suggest all the claim limitations. <u>See</u> MPEP § 2143.

1. <u>No Prima Facie Case of Obviousness - There is no Motivation or Suggestion to Combine the Cited References</u>.

Appellant respectfully submits that the evidence of record provided in the most recent Office Action is insufficient to establish an obviousness rejection. In particular, it is respectfully submitted that there is no sufficient suggestion or motivation to combine the Ogata et al. and Barnes et al. references. The Examiner provides motivation to combine on page three of the Office Action and states:

> It would have been obvious to one of ordinary skill in the art that the hand held computer input device of Barnes et al. which can be physically manipulated and have those signals associated with the movements transmitted to the computer be incorporated into that of Ogata et al. Ogata et al. also disclosed in

> FIG. 38, col. 21, lines 50-60 a gyroscope. It is known to one skilled in the art that a gyroscope can be used for physical movement, thus it is possible for Ogata et al. device to also incorporate physical movement.

Appellant respectfully submits that one skilled in the art would not turn to the teachings of Barnes et al. for measuring physical manipulation of the game controller since Ogata et al. provides such a teaching. Ogata et al. is primarily directed to sensing controller attitude to allow the game machine to correct the dynamic transmission data sent to the control module such that the variation in vibration on the vibrator can be avoided due to gravity. See col. 27, lines 66-67 to col. 28, lines 1-16. However, it is respectfully pointed out that Ogata et al. (in col. 34, lines 37-56) discloses that the angular velocity sensors are not limited to correcting vibration variation. The angular velocity sensor can be transmitted to the game machine "in place of input from the control button." It is respectfully submitted that the suggestion proffered by the Examiner to combine Barnes et al. with Ogata et al. is erroneous.

In addition, Barnes et al. does not suggest the combination. Barnes et al. merely discloses rotational and attitude information. The Examiner does not give any indication as to why one skilled in the art would have been so motivated to conceive features, such as assembling orientation information and multiple-switch information into an orientation field and multiple switch field of a data packet, that are neither taught nor suggested by either of the cited references.

2. No Prima Facie Case of Obviousness - There is no Teaching or Suggestion of All Recited Claim Limitations.

Appellant respectfully submits that the evidence of record provided in the most recent Office Actions is insufficient to

establish an obviousness rejection. In particular, it is respectfully submitted that even if the Ogata et al. and Barnes et al. were combined, the cited references simply do not teach or suggest all the claim limitations as recited in claims 1, 10, 16 and 20 of the present invention.

The latest Office Action refers to FIG. 5, items 7 and 8, col. 7, lines 51-57 and col. 9, lines 24-46 of Ogata et al. as disclosing "a hand held computer input device which prepares a data packet indicative of receiving information of a configuration of a multiple switch device located on the computer input device and having at east two degrees of motional freedom." The Office Action then reports that Ogata et al. does not disclose physical orientation, but that Barnes et al. discloses providing positional and attitude information to a computer in FIGS. 6A-D and col. 9, lines 16-60.

It is respectfully submitted that the proposed combination of Ogata et al. and Barnes et al. does not teach or suggest the claim limitation of placing data in a data packet that contains both physical orientation information <u>and</u> multiple switch information related to an input device having at least two degrees of motional freedom. Although Ogata et al. discloses a data packet in col. 9, lines 24-46, the data packet is (as discussed in col. 9, lines 18-46) created at the game machine and is mono-directionally transmitted from the game machine to the control module in order to control the vibrator member. Thus, Ogata et al. does not teach or suggest that a data packet is prepared by the control module, as suggested by the Examiner, and Ogata et al. does not teach or suggest that the data packet contains information related to a configuration of a multiple switch device. The data packet of Ogata et al. contains information related to dynamic transmission data. In addition, although Barnes et al. discloses providing rotational and attitude information as discussed in the Office Action, the combination of Ogata et al. and Barnes et al. does not disclose

data packets inherent

placing data in a data packet that contains both physical orientation information <u>and</u> multiple switch information related to an input device having at least two degrees of motional freedom.

Although not indicated by the Examiner in the Office Action, Ogata et al. discloses that, in the alternative, the angular velocity sensors can determine the altitude of the control module and transmit the variation in altitude to the game machine "in place of input from the control button." See column 34, lines 44-50. Even if the Examiner had referenced this language as showing that Ogata et al. teaches transmitting physical orientation to a computer, this language does not teach or suggest placing data in a data packet that contains both physical orientation information <u>and</u> multiple switch information related to an input device having at least two degrees of rotational freedom. At best, the language in Ogata et al. describes sending positional information in place of button information. Ogata et al. does not teach or suggest sending orientation <u>and</u> multiple switch information in a data packet. Ogata et al. also does not teach or suggest sending both physical orientation <u>and</u> multiple switch information to a computer. It is respectfully submitted that claims 1, 10, 16 and 20 are allowable over the cited references.

<u>Rejection of Group II Claims</u>

Claims 2, 7-9 and 23 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Ogata et al. in view of Barnes et al. Appellant submits that this combination fails to render the Group II claims obvious.

cl. 2 is broad interpretation you can place data in any way.

Claims 2 and 7-9 depend on claim 1 and relate to receiving and placing information indicative of a selected mode. Claim 23 is an independent claim and includes all of the limitations of claim 1 and also receiving mode information. In addition to the arguments discussed in this section, all of the arguments discussed above in Group I also apply to claims 2, 7-9 and 23.

Detailed descriptions of claims 2, 7-9, 22 and 23 are described in the Appeal Brief filed July 8, 2003 in Groups II and XV.

On page three, the Office Action refers to col. 8, lines 37-53 and column 9, lines 16-60 of Barnes et al. as teaching the features of claims 2, 7-9 and 23. In this section, Barnes et al. described a system operating in two-dimensional (2D) and three-dimensional (3D) operating modes. Barnes et al. also described receiving positional information in the 3D mode and also receiving positional information using input from keys. However, Barnes et al. does not teach or suggest placing data in a data packet based on mode. Although Barnes et al. shows different modes (2D vs. 3D), Barnes et al. does not teach or suggest variable packetizing based on mode. It is respectfully submitted that claims 2, 7-9 and 23 are allowable over the cited references.

Rejection of Group III Claims

Claims 3-6 and 22 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Ogata et al. in view of Barnes et al. Appellant submits that this combination fails to render the Group III claims obvious.

Claims 3-6 depend on claim 2 and relate to placing information in a data packet based on a selected mode. Claim 22 depends on claim 20 and relates to a mode selector configured to receive mode information indicative of a selected mode. In addition to the arguments presented in this section, all of the arguments discussed above in Groups I and II also apply to claims 3-6 and 22. A detailed description of claims 3-6 and 22 are described in the Appeal Brief filed July 8, 2003 in Groups III, IV, and XIV.

Pages four, five and seven of the Office Action refer to column 7, lines 50-60 of Ogata et al., and the Office Action refers to column 8, lines 37-53 and column 9, lines 19-60 of Barnes et al. as teaching the features of claims 3-6 and 22. The section referred to in Ogata et al. discloses a game machine first

outputting data to cause the game machine to communicate with a control module. Ogata et al. also discloses capturing button information from the control module. The referred sections of Barnes et al. disclose a system as discussed in Group II above. Ogata et al. and Barnes et al., however, do not teach or suggest placing orientation information in an orientation field based on a selected mode or placing multi-switch data in an orientation field based on a selected mode as claimed. In addition, neither Ogata et al. nor Barnes et al. teach or suggest a mode selector configured to receive mode information and place data in an orientation and a multiple switch field based on a selected mode. It is respectfully submitted that claims 3-6 and 22 are allowable over the cited references.

Rejection of Group IV Claims

Claims 11 and 12 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Ogata et al. in view of Barnes et al. Appellant submits that this combination fails to render the Group IV claims obvious.

Claims 11 and 12 depend on claim 10 and relate to placing data in the orientation field and the multiple-switch field in the data packet based on a selected mode as performed on the computer by the input device driver. In addition to the arguments presented in this section, all of the arguments discussed above in Group I, II and III apply to claims 11 and 12. Detailed descriptions of claims 11 and 12 are described in the Appeal Brief filed July 8, 2003 in Groups VI and VII.

On page six, the Office Action refers to column 8, lines 37-62 and column 9, lines 16-60 of Barnes et al. as teaching the features of claims 11 and 12. However, Barnes et al. neither teaches nor suggests placing or replacing data in an orientation field and a multiple switch field based on a selected mode which is performed on the computer by the input device driver. It is respectfully submitted that claims 11 and 12 are allowable over

the cited references.

Rejection of Group V Claims

Claims 13-15 and 17-19 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Ogata et al. in view of Barnes et al. Appellant respectfully submits that this combination fails to render the Group V claims obvious.

Claim 13 is an independent claim and recites a method of preparing a data packet indicative of operator manipulation of a handheld computer input device. Independent claim 13 includes placing data in an orientation field and placing data in a rotation field in the data packet based on the orientation information and the rotation information of a rotatable member. Claims 14 and 15 depend on claim 13 and further include receiving switch information and receiving button information. Claims 17-19 depend on claim 16 and further include a rotation field containing rotation information indicative of rotation of a rotatable member. The rotation field also includes a button field and a mode field. Detailed descriptions of claims 13-15 and 17-19 are described in the Appeal Brief filed July 8, 2003 in Groups VIII-XII.

On page seven, the Office Action refers to column 9, lines 16-60 as teaching the features of claims 13-15 and 17-19. In this section, Barnes discloses pitch, yaw and roll types of rotation of the input device which is then transmitted to the computer. However, Barnes et al. does not teach or suggest a rotatable member on the input device. Barnes et al. also does not teach or suggest placing information indicative of a rotatable member into a rotation field. Barnes et al. merely describes rotating the entire input device. Rotating an entire input device is not a teaching and suggestion of rotation of a rotatable member on the input device. It is respectfully submitted that claims 13-15 and 17-19 are allowable over the cited references.

read the rotatable member as entire handheld device
claim is so broad that can be

CONCLUSION

The cited combination of references in the latest Office Action fails to teach or suggest the features recited in the pending claims. Also, there is no motivation to combine the cited references. Appellants respectfully request that the Board reverse the Examiner and find that claims 1-20 and 22-23 are in condition for allowance.

Respectfully submitted,

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APPENDIX A

PENDING CLAIMS 1-20, 22 AND 23

1. A method of preparing a data packet indicative of operator manipulation of a hand held computer input device, the method comprising:

receiving information indicative of a physical orientation of the computer input device;

receiving information indicative of a configuration of a multiple-switch device located on the computer input device and having at least two different degrees of motional freedom wherein movement of the multiple-switch device in the different degrees of motional freedom causes actuation of different switches in the multiple-switch device; and

placing data in an orientation field and a multiple-switch field in the data packet.

2. The method of claim 1 and further comprising:

receiving information indicative of a selected mode of a plurality of selectable modes of operation; and

placing the data in the orientation field and the multiple-switch field in the data packet based on the selected mode.

3. The method of claim 2 wherein the step of placing the data comprises:

placing orientation data indicative of the physical orientation of the computer input device in the orientation field when the selected mode is a first selected mode; and

placing predetermined orientation data in the orientation field when the selected mode is a second selected mode,

the predetermined orientation data corresponding to the configuration of the multiple-switch device.

4. The method of claim 3 wherein placing predetermined orientation data comprises:

selecting a predetermined orientation value from a plurality of predetermined orientation values based on the configuration of the multiple-switch device.

5. The method of claim 3 wherein placing the data further comprises:

placing predetermined switch configuration data in the multiple-switch field when the selected mode is the second selected mode.

6. The method of claim 5 wherein the predetermined switch configuration data corresponds to depression of no switches in the multiple-switch device.

7. The method of claim 2 wherein the step of placing the data in the orientation field and the multiple switch field in the data packet based on the selected mode is performed on the computer input device.

8. The method of claim 2 wherein the computer input device is coupled to a computer and wherein the step of placing the data in the orientation field and the multiple switch field in the data packet based on the selected mode is performed on the computer.

9. The method of claim 8 wherein the computer includes an input device driver and wherein the step of placing the data in the orientation field and the multiple switch field in the data packet based on the selected mode is performed on the computer by the input device driver.

10. The method of claim 1 wherein the step of placing the data in the orientation field and the multiple switch field in the data packet based on the selected mode is performed on the computer by the input device driver by:

receiving an input device data packet comprising an orientation field including orientation information indicative of the physical orientation of the computer input device, a multiple-switch field including switch information indicative of the configuration of the multiple-switch device and a mode field including mode information indicative of the selected mode; and

maintaining the orientation information in the orientation field and the switch information in the multiple-switch field when the selected mode is a first selected mode.

11. The method of claim 10 wherein the step of placing the data in the orientation field and the multiple switch field in the data packet based on the selected mode is performed on the computer by the input device driver by:

replacing the orientation information in the orientation field with a predetermined orientation value, based on the switch information, when the selected mode is a second selected mode.

12. The method of claim 11 wherein the step of placing the data in the orientation field and the multiple switch field in the data packet based on the selected mode is performed on the computer by the input device driver by:

replacing the switch information in the multiple-switch field with a predetermined value when the selected mode is the second selected mode.

13. A method of preparing a data packet indicative of operator manipulation of a hand held computer input device, the method comprising:

receiving orientation information indicative of a physical orientation of the computer input device;

receiving rotation information indicative of rotation of a rotatable member on the computer input device; and

placing data in an orientation field and a rotation field in the data packet based on the orientation information and the rotation information.

14. The method of claim 13 and further comprising

receiving switch information indicative of a configuration of a multiple-switch device on the computer input device; and

placing data in a multiple-switch field in the data packet based on the switch information.

15. The method of claim 14 and further comprising

receiving button information indicative of depression of a plurality of buttons on the computer input device; and

placing data in a button field in the data packet based on the button information.

16. A data structure generated by a computer input device for transmission to a computer, comprising:

an orientation field containing orientation data indicative of a pitch and roll physical orientation of the computer input device; and

a switch field containing switch information indicative of a multiple-switch device located on the computer input device and having at least two different degrees of motional freedom wherein movement of the multiple-switch device in the different degrees of motional

freedom causes actuation of different switches in the multiple-switch device.

17. The data structure of claim 16 and further comprising:
a rotation field containing rotation information indicative of rotation of a rotatable member on the computer input device.

18. The data structure of claim 17 and further comprising:
a button field containing button information indicative of depression of buttons on the user input device.

19. The data structure of claim 18 and further comprising:
a mode field containing mode information indicative of a state of a mode selector on the computer input device.

20. A computer input device, comprising:
a first housing portion including at least one user actuable input device;
a first extending handle, coupled to and extending away from, the first housing portion;
a second extending handle, coupled to and extending from the first housing portion;
an orientation sensor coupled to the first housing portion and sensing a physical orientation of the first housing portion and providing an orientation signal indicative thereof;
a controller coupled to the orientation sensor and configured to receive the orientation signal and place data in an orientation field, based on the orientation signal, in a data packet;
a multiple-switch device having at least two different degrees of motional freedom and actuable by an operator such that movement of the multiple switch device in the

different degrees of motional freedom causes actuation of different switches in the multiple-switch device, the controller being configured to receive switch information indicative of a configuration of the multiple-switch device and to place switch data in a multiple-switch field in the data packet based on the switch information.

22. The computer input device of claim 20 and further comprising:

a mode selector, actuable by an operator, the controller being configured to receive mode information indicative of a selected mode of a plurality of selectable modes of operation and to place the data in the orientation field and the multiple-switch field in the data packet based on the selected mode.

23. A method of controlling a visual display on a computer display device based on an input from a computer input device, the method comprising:

receiving orientation information indicative of a physical orientation of the computer input device;

receiving switch information indicative of a configuration of a multiple-switch device located on the computer input device and having at least two different degrees of motional freedom wherein movement of the multiple-switch device in the different degrees of motional freedom causes actuation of different switches in the multiple-switch device;

receiving mode information indicative of a selected mode of operation; and

controlling the display device such that an object being displayed on the visual display device assumes a visual

orientation corresponding to one of, the physical orientation of the computer input device as indicated by the orientation information and the configuration of the multiple-switch device as indicated by the switch information, based on the selected mode.

APPENDIX B

REFERENCES CITED BY EXAMINER

EXHIBIT A: Ogata et al. (U.S. Patent No. 6,001,014)

EXHIBIT B: Barnes et al. (U.S. Patent No. 6,069,594)

US006069594A

United States Patent [19]

Barnes et al.

[11] **Patent Number: 6,069,594**

[45] **Date of Patent: May 30, 2000**

[54] **COMPUTER INPUT DEVICE WITH MULTIPLE SWITCHES USING SINGLE LINE**

[75] Inventors: **James Barnes**, Campbell; **Ron Mc Clure**, Oakland, both of Calif.; **David Glickman**, Baltimore, Md.

[73] Assignee: **Logitech, Inc.**, Fremont, Calif.

[21] Appl. No.: **08/706,515**

[22] Filed: **Sep. 4, 1996**

Related U.S. Application Data

[63] Continuation of application No. 08/382,774, Feb. 2, 1995, abandoned, which is a continuation of application No. 07/737,074, Jul. 29, 1991, abandoned.

[51] **Int. Cl.**[7] **G09G 5/00**

[52] **U.S. Cl.** **345/7**; 345/158; 345/156

[58] **Field of Search** .... 345/156, 157, 345/158, 163, 7, 161; 74/471 XY; 381/122

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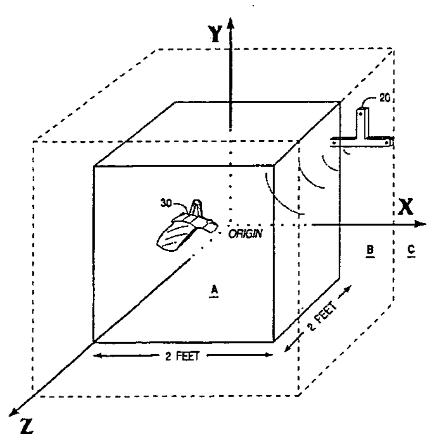
[57] **ABSTRACT**

Apparatus and methods for providing positional and attitude information to a computer. An input device of the present invention comprises a controller, a transducer, and a mouse. In a 6D mode of operation, three-dimensional positional information with three degrees of freedom is provided to the computer. Multiple switches use an impedance ladder to provide multiple signals over a control line from a movable input device for a cursor or viewpoint on a display.

1 Claim, 10 Drawing Sheets



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5,225,831	7/1993	Osborn	341/20
5,245,320	9/1993	Bouton	345/167
5,252,970	10/1993	Baronowsky	341/20
5,253,836	10/1993	Tso	248/225
5,296,846	3/1994	Ledley	345/161
5,298,919	3/1994	Chang	345/163
5,389,950	2/1995	Bouton	345/156

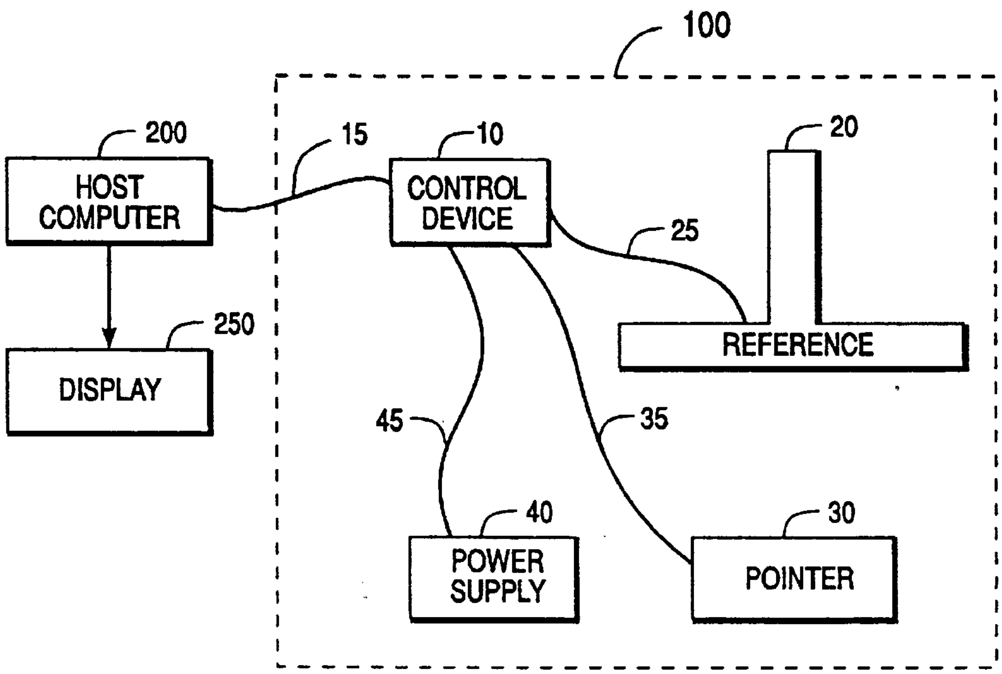
100
200
HOST COMPUTER
15
10
CONTROL DEVICE
20
25
250
DISPLAY
REFERENCE
45
35
40
POWER SUPPLY
30
POINTER

FIG. 1A

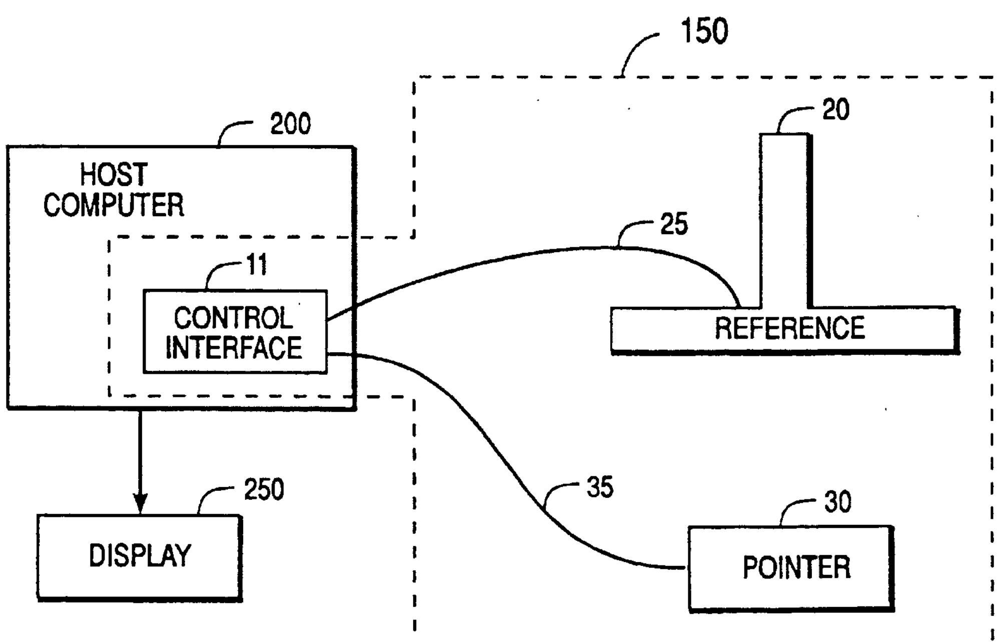
150
200
HOST COMPUTER
20
25
11
CONTROL INTERFACE
REFERENCE
250
DISPLAY
35
30
POINTER

FIG. 1B

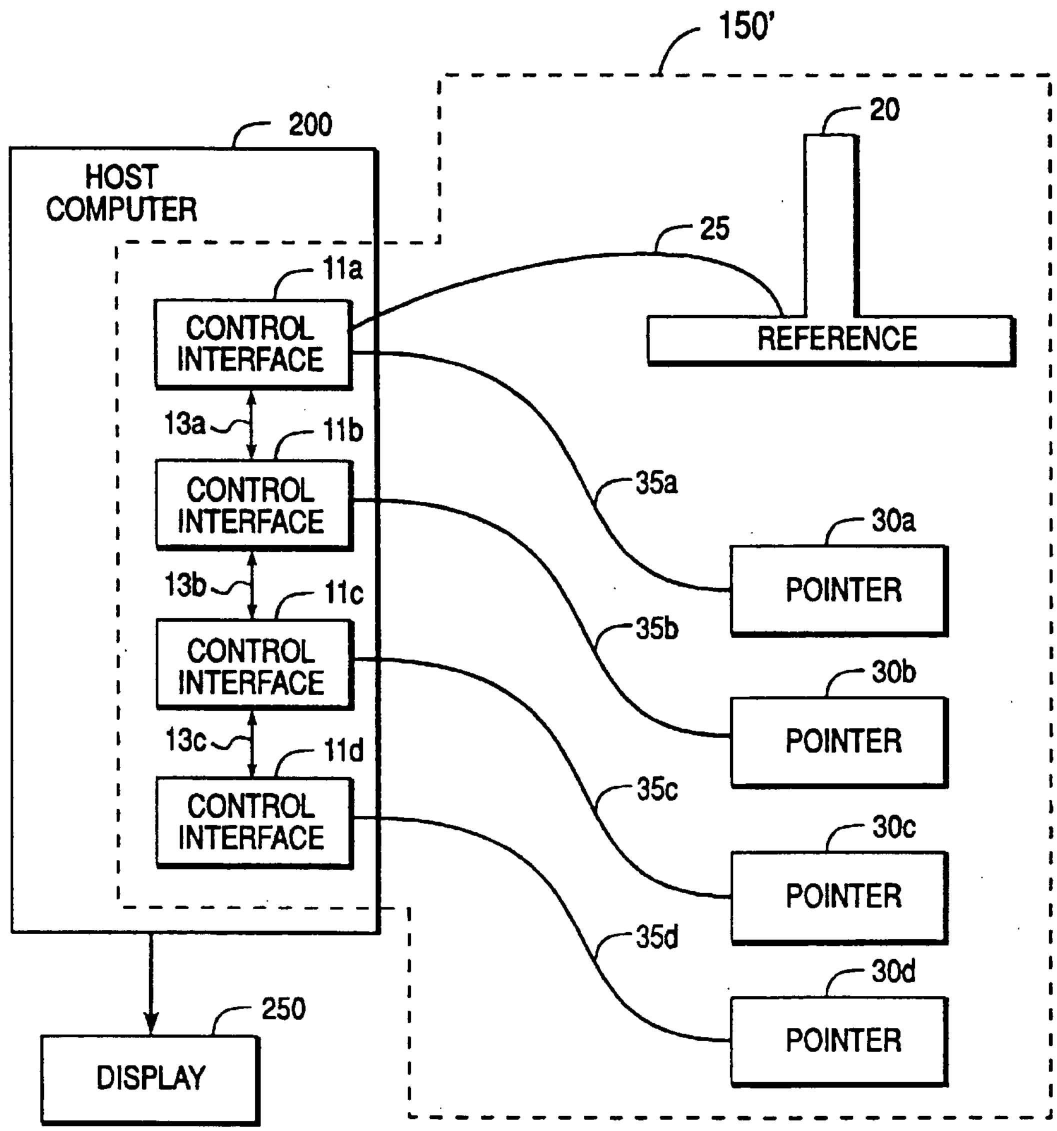
150'
200
HOST COMPUTER
20
25
11a
CONTROL INTERFACE
REFERENCE
13a
11b
CONTROL INTERFACE
35a
30a
POINTER
13b
11c
CONTROL INTERFACE
35b
30b
POINTER
13c
11d
CONTROL INTERFACE
35c
30c
POINTER
35d
30d
POINTER
250
DISPLAY

FIG. 1C

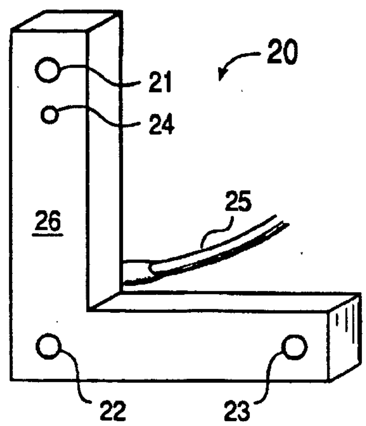

FIG. 2A

20

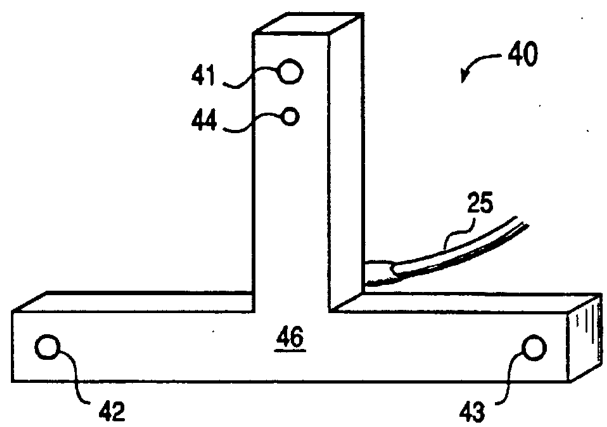

FIG. 2B

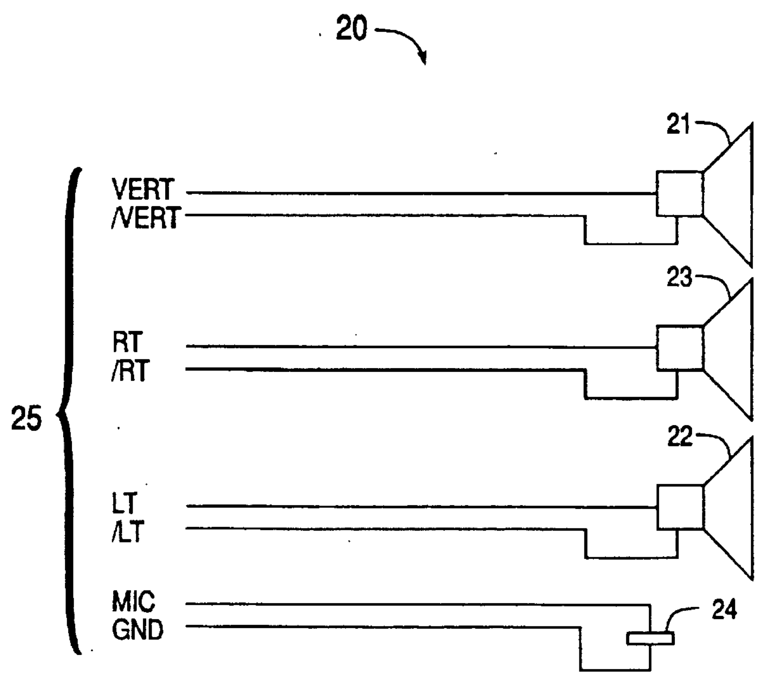

FIG. 2C

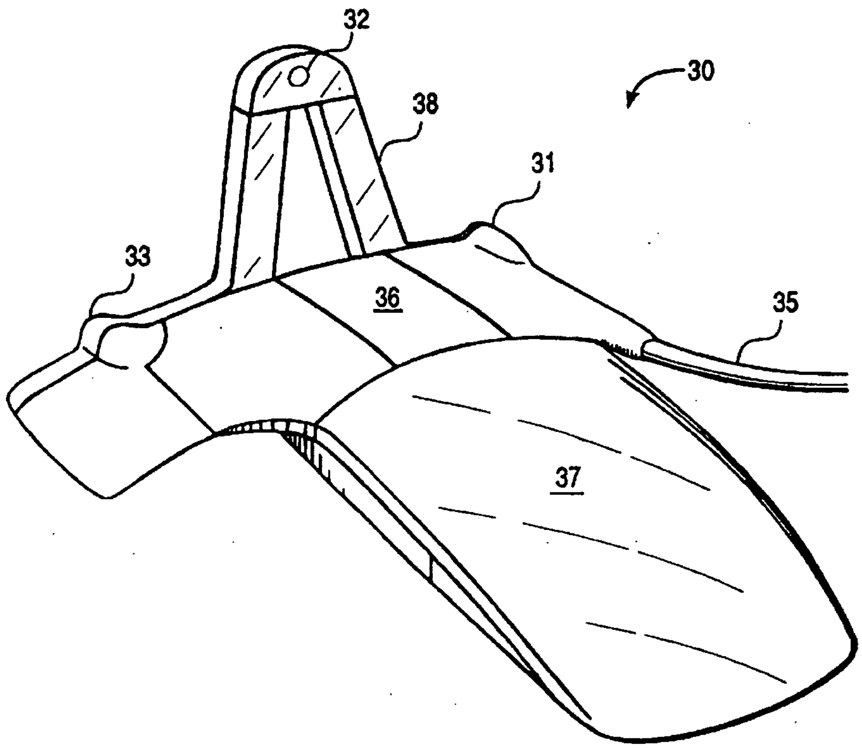
32
30
38
31
33
36
35
37

FIG. 3A

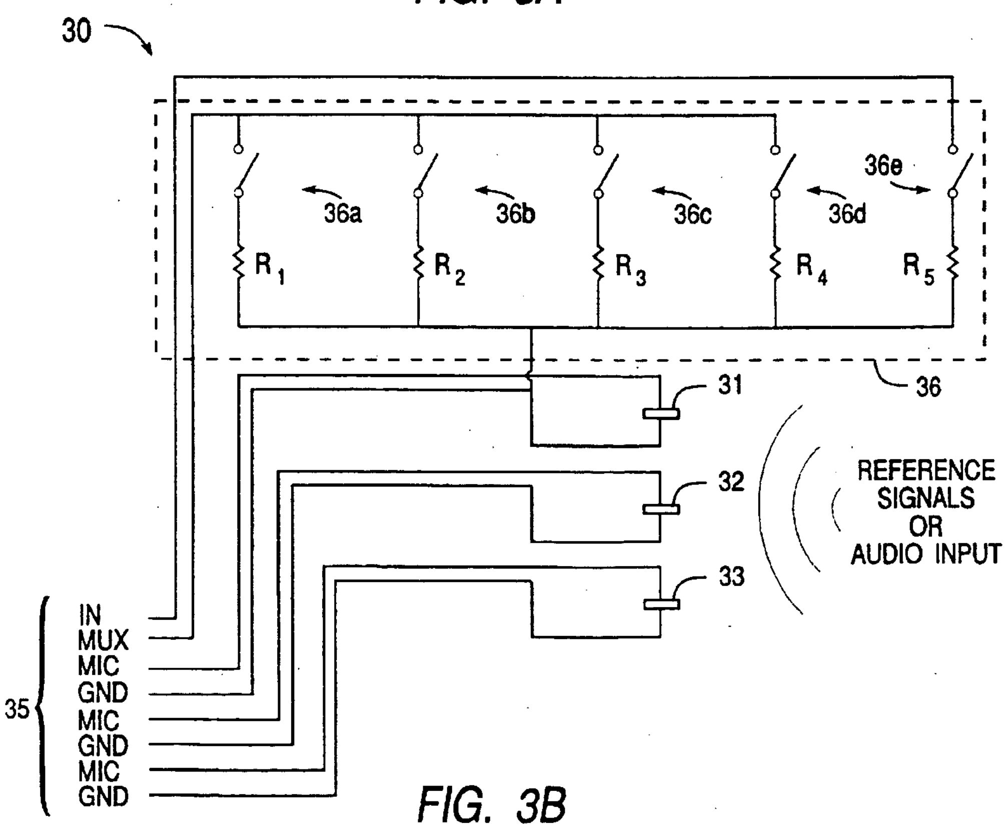
30
36a
36b
36c
36d
36e
R_1
R_2
R_3
R_4
R_5
36
31
32
33
REFERENCE SIGNALS OR AUDIO INPUT
IN
MUX
MIC
GND
MIC
GND
MIC
GND
35

FIG. 3B

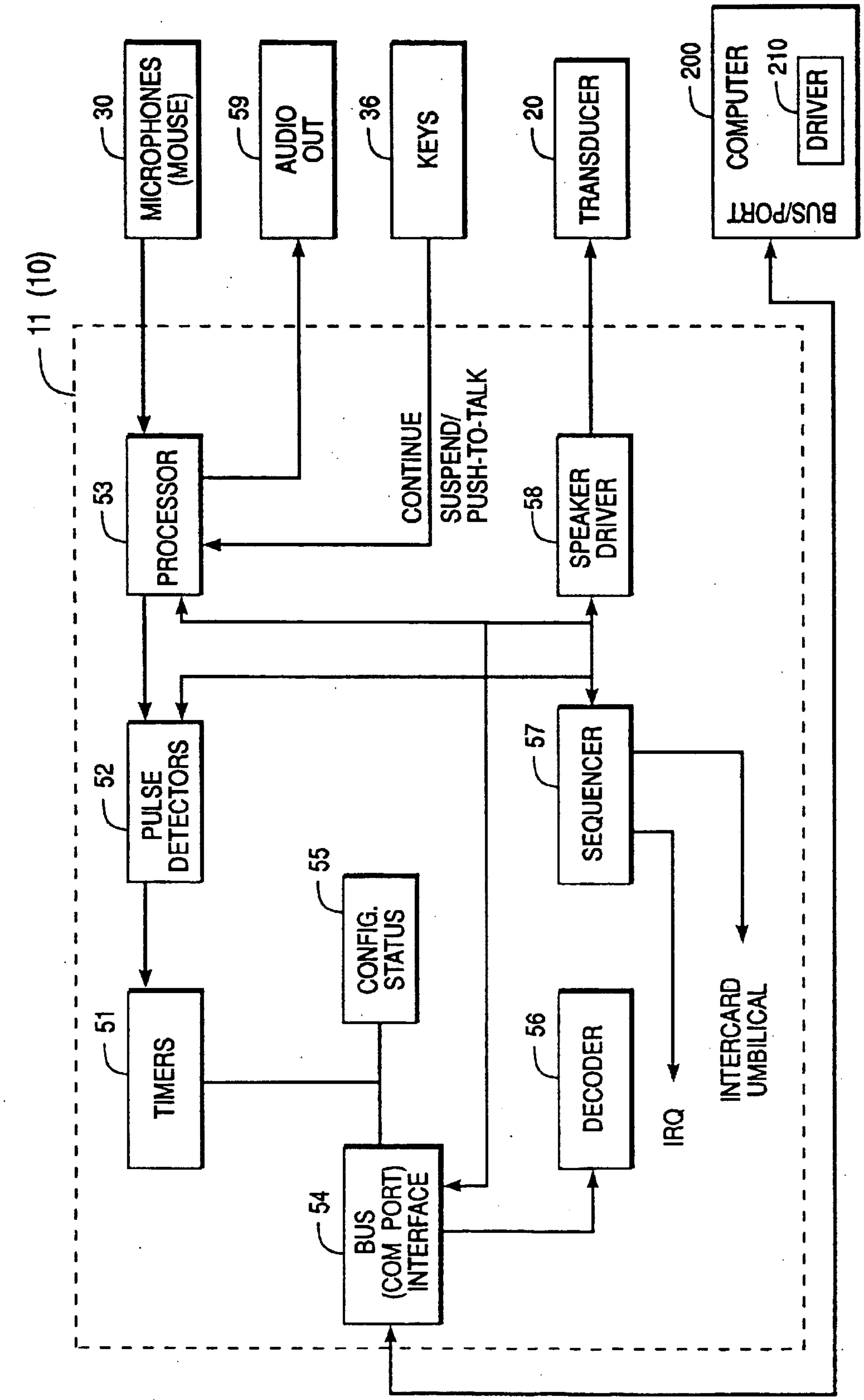
11 (10)
30
MICROPHONES (MOUSE)
59
AUDIO OUT
36
KEYS
20
TRANSDUCER
200
COMPUTER
210
DRIVER
BUS/PORT
53
PROCESSOR
CONTINUE
SUSPEND/ PUSH-TO-TALK
58
SPEAKER DRIVER
52
PULSE DETECTORS
57
SEQUENCER
55
CONFIG. STATUS
51
TIMERS
56
DECODER
IRQ
INTERCARD UMBILICAL
54
BUS (COM PORT) INTERFACE

FIG. 4

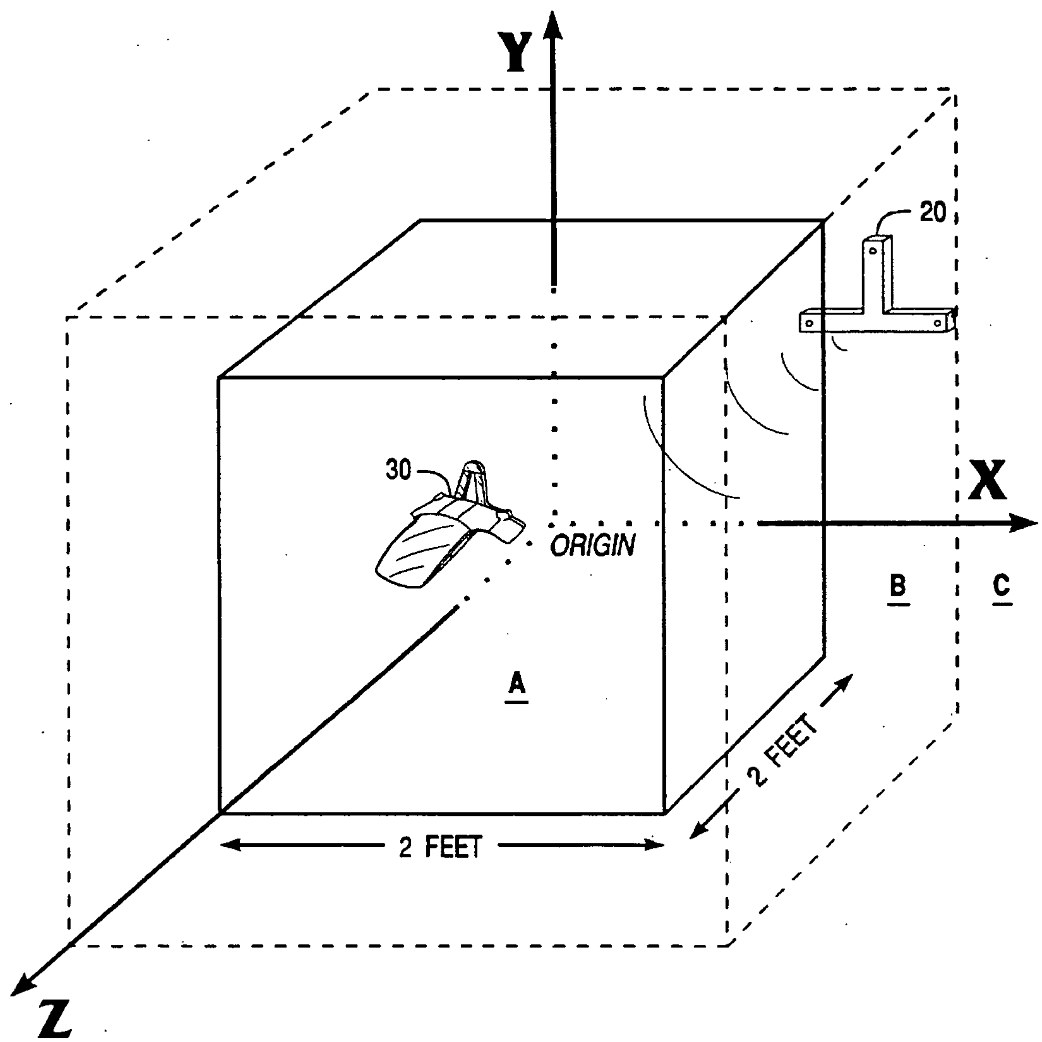

FIG. 5

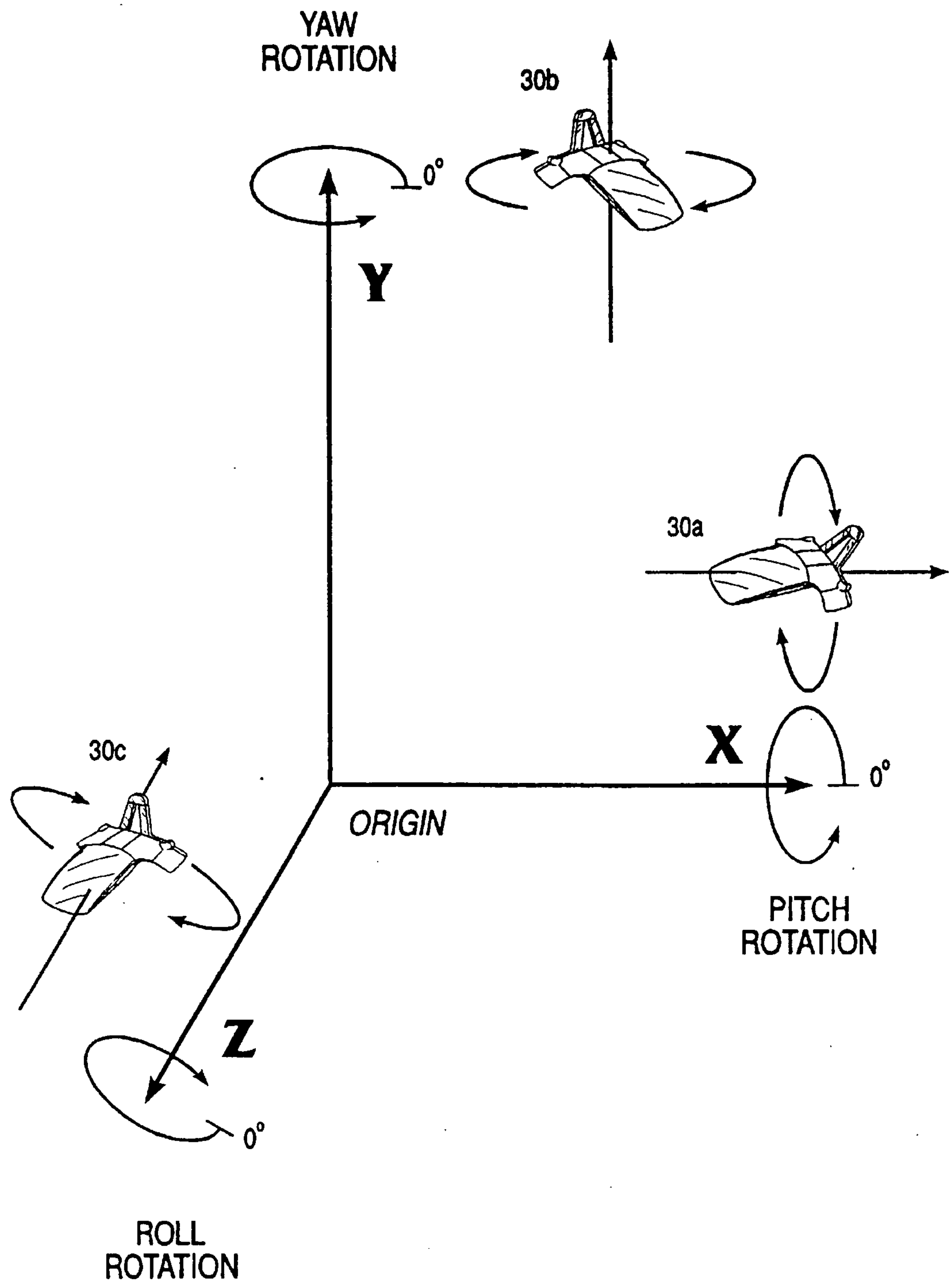
YAW
ROTATION
30b
0°
Y
30a
X
0°
30c
ORIGIN
PITCH
ROTATION
Z
0°
ROLL
ROTATION

FIG. 6A

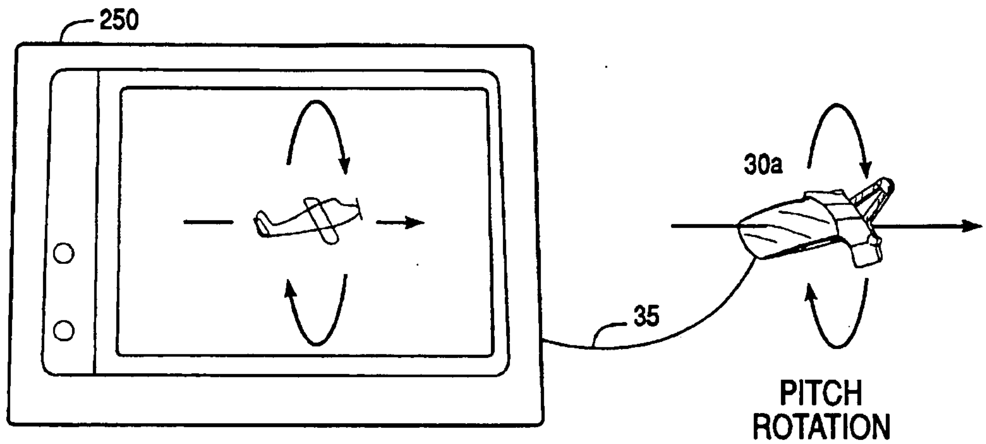

FIG. 6B

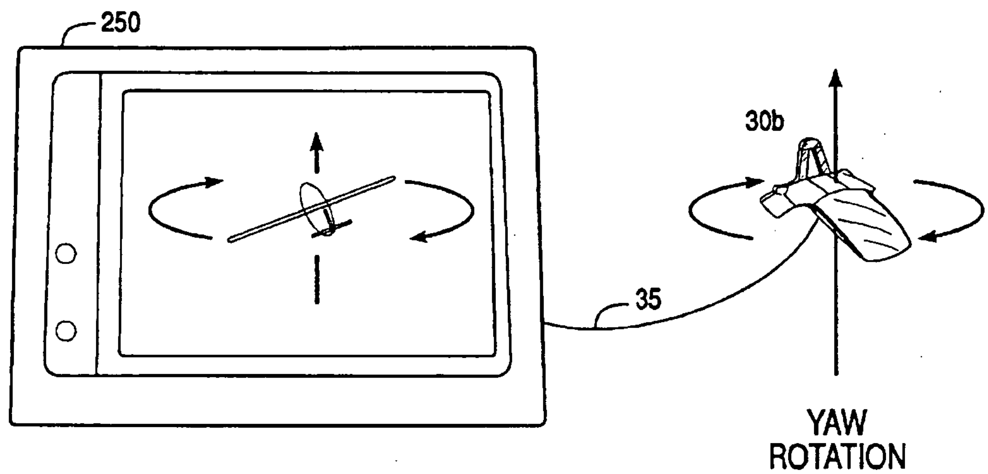

FIG. 6C

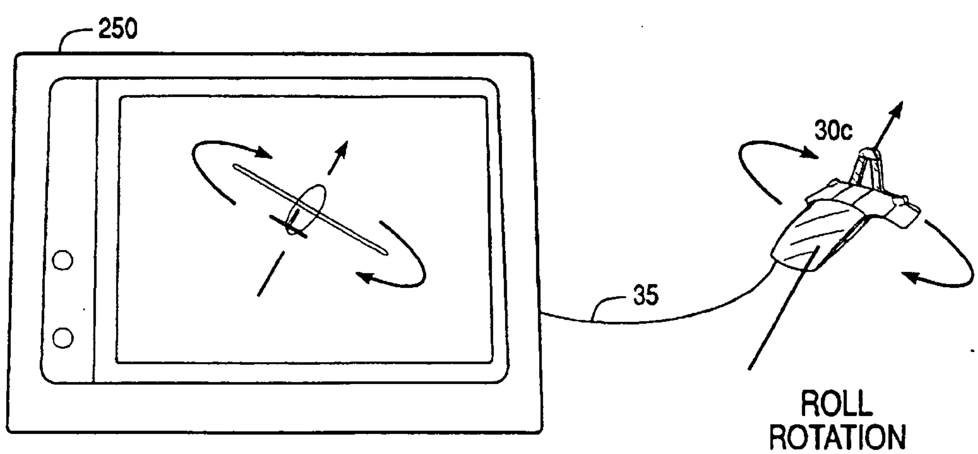

FIG. 6D

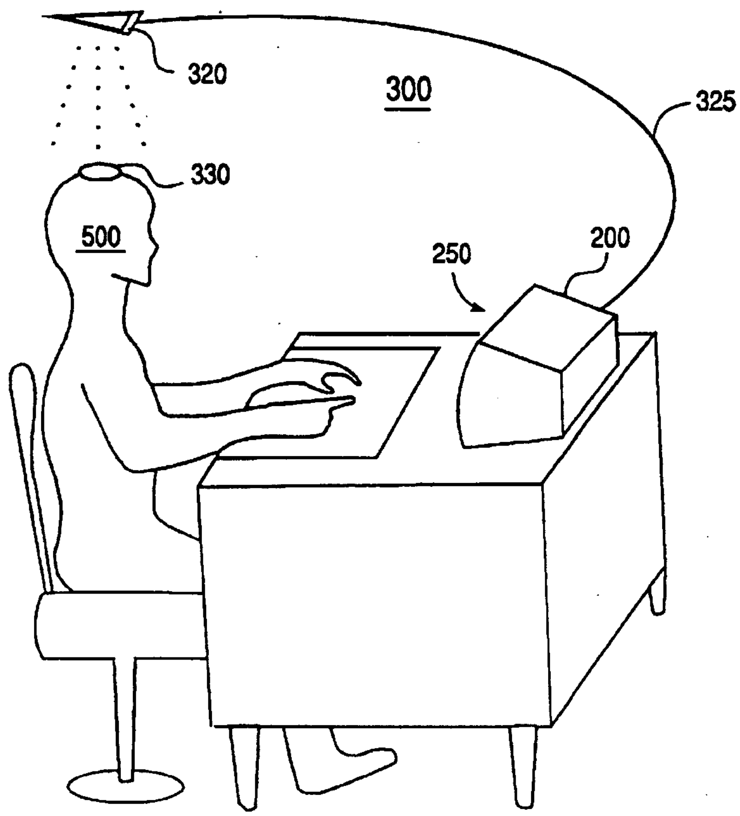

FIG. 7

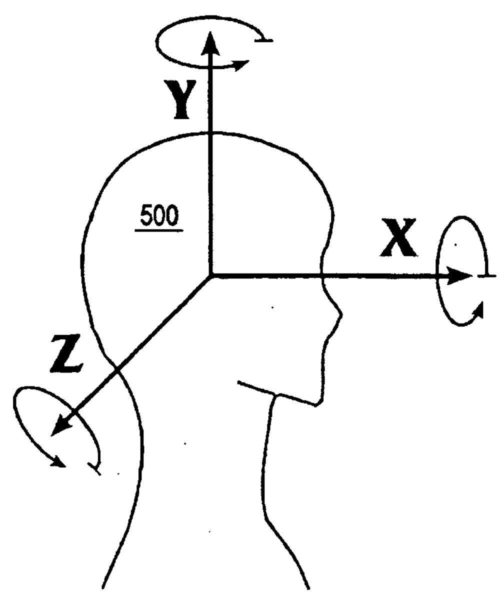

FIG. 8

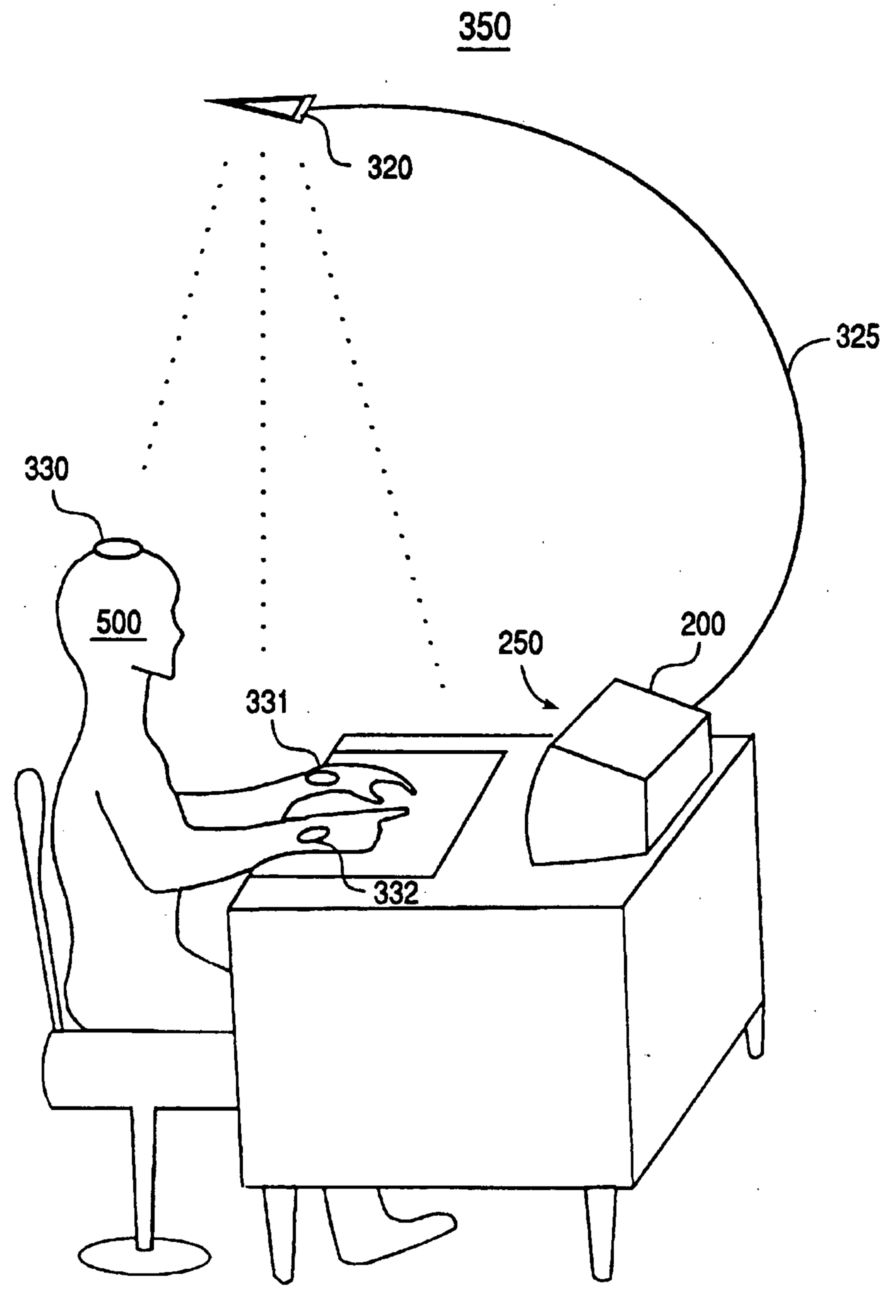

FIG. 9

COMPUTER INPUT DEVICE WITH MULTIPLE SWITCHES USING SINGLE LINE

This is a continuation of application Ser. No. 08/382,774, filed Feb. 2, 1995, now abandoned, which is continuation of Ser. 07/737,074 filed Jul. 29, 1991, now abandoned.

FIELD OF THE INVENTION

The invention relates generally to input systems for computers and, more particularly, a system for controlling a cursor on a video display of a computer.

BACKGROUND OF THE INVENTION

Users of a computer typically enter input using either a keyboard or a pointing device. The latter, which is of particular interest to the present invention, includes such well-known devices as mice, joy sticks, track balls, light pens, and the like.

The operation of "mice" is typical of pointing devices. Movement of a mouse, which is typically held in the user's hand, causes a position indicator (cursor) on a video display connected to the computer to move in relatively the same direction and magnitude. The mouse usually includes a pair of transducers which detect the movement of the mouse in two orthogonal directions; in turn, these motion signals are supplied to the computer. In addition, mice often include two or three keys which can be depressed for supplying additional signals to the computer, e.g., for selecting choices from a displayed menu.

There are two basic types of mice: mechanical and optical. Mechanical mice employ an inverted track ball or "rollerball" which is rolled across a desk or other planar surface by the user. Two rollers touching the ball record its movement along X and Y axes. As the rollers rotate, encoders make and break electrical contact and send corresponding electrical pulses that the computer can use to track movement. Alternatively, some mechanical mice forego the rollerball and instead employ two rollers which protrude from the bottom of the mouse to sense the X and Y directional movements directly. In either, case friction (mechanical) contact is made with a planar surface, with movement along that surface generating motion signals.

Optical mice, on the other hand, employ a special reflective mouse pad instead of a rollerball. An optical mouse has two LEDs that shine two light beams, one red and one infrared, onto the mouse pad. Reflected light beams re-enter the mouse through lenses which focuses the light onto photodetectors. As the mouse moves, the pad alternately absorbs and reflects light; blue lines on the pad absorb the red light while black lines absorb the infrared light. The photodetectors detect the "makes" and "breaks," which the mouse converts to signals for the computer.

An optomechanical mouse, a hybrid, employs both mechanical and optical means to detect movement. Like the mechanical mouse, the optomechanical mouse employs a rollerball. Instead of using electrical contacts, however, the optomechanical mouse uses two LED/photodetector pairs to detect movement along X and Y axes. As the roller rotates, the encoders alternately make and break light beams which shine between each LED/photodetector pair. Corresponding electric signals are sent to the computer to describe the motions of the mouse.

Regardless of the type, all of the foregoing mice generate motion signals by dragging a mouse device across a flat surface, such as a desk top. Commonly, a corresponding

display cursor moves across the video display. Typically, though, the cursor tracks the relative movement of the mouse, not its absolute or physical movement. To allow the user to move the cursor with some precision, the ratio of mouse movement to cursor movement (mouse "sensitivity") is usually much less than one. In other words, a large mouse movement is mapped as a small cursor movement on the screen. This allows better fine motor manipulation of the cursor on the screen.

Occasionally, however, the user will want to move the cursor across a large screen distance, for example, from one side of the display to another. This is accomplished by "stroking" the mouse: repeatedly dragging the mouse across the desk top in a stroking fashion. In between each stroke (i.e., during back stroke), the mouse is lifted off the desk so that mechanical or optical contact is lost. Since no motion signals are generated during the reverse or back stroke, the cumulative effect is movement of the cursor in the stroke direction only.

In addition to the basic mouse design, a variety of other computer input designs are known. U.S. Patent No. 4,654, 648, for example, describes a position control system having a wireless moveable "steering means" which emits acoustic signals, tracking means for receiving the acoustic signals and determining the position of the steering means by hyperbolic triangulation, and means for communicating the position of the steering means to a video display terminal. U.S. Pat. No. 4,578,674 describes a wireless cursor position device which operates by transmitting and receiving ultrasonic and infrared signals between the device and a control base. The control base includes an infrared emitter and at least two ultrasonic detectors; for three-dimensional (3-D) cursor control, additional ultrasonic detectors are required.

Cordless or wireless variants of input devices are known. U.S. Pat. No. 4,550,250, for example, describes a cordless input device which includes a pulse-driven light source whose duty cycle is controlled for conveying information. The detector has a housing with two spaced-apart optical slits for passing planes of infrared light onto concave light guides. The light guides, along with photoelectric sensors, produce positionally dependent, analog signals. The signals are processed by a microprocessor to determine the Cartesian coordinates of the device. U.S. Pat. No. 4,754,268 also describes a cordless input device. The cordless mouse indicates movement of the device on a planar surface by transmitting radiowaves to a host computer.

The keys of mouse devices have also been refined. U.S. Pat. No. 4,994,795, for example, describes a mouse input device having a plurality of programmable keys, with one embodiment including forty keys. A program controls the input device so that key signals are given priority. In the event that both key and motion signals occur, the key signals are supplied to the computer. If no key signal occurs, however, then motion signals are converted into key signals and are supplied to the computer.

While the prior art includes input devices having a variety of configurations (e.g., mouse, stylus, track ball, and the like) and means for communicating movement to a computer (including both cord and cordless models), the prior art input devices are largely confined to conveying two-dimensional (2-D) movement, i.e., movement along a planar surface. Of those systems which suggest a three-dimensional input device, the information conveyed to a computer is limited to positional information, i.e., the location of the device within an X, Y, and Z coordinate system.

SUMMARY OF THE INVENTION

According to the present invention, apparatus and methods are provided for detecting and communicating positional

and orientation information to a computer. The invention is particularly useful for computer systems which require attitudinal input in addition to positional input within 3-D space.

The apparatus of the present invention is a position and orientation indicating device for use with a computer having a video display; the display conveys positional and attitudinal or orientation information from the input device to the user. The input device includes both transmitter and pointer (receiver) apparatus. In one embodiment, the transmitter device comprises three transducers for generating motion signals from a stationary location. The pointer apparatus, which includes at least three microphone elements for receiving the motion signals, is a user-held (or worn) pointer which may be moved in 3-D space.

Control circuitry, which is connected to both the transmitter and pointer devices, determines a position and attitude (i.e., angular orientation) of the pointer. In particular, the control circuitry determines the three-dimensional position as well as yaw, pitch, and roll from the time required (i.e., the propagation delay) for each motion signal to reach each of the pointer microphones.

The pointer device, which is in the form of a mouse device in one embodiment, may include a plurality of keys which may be activated for supplying user input to the device; these inputs are converted into signals and communicated to the computer.

Alternate embodiments of the present invention are also described. In one alternate embodiment, for example, the pointer device is in the form of a head tracker which may be worn on a user's head. In another embodiment, a plurality of pointer devices are provided for simultaneously tracking the position and attitude of several pointers in 3D space; pointers may be conveniently worn on the head and each hand of the user.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is a block diagram of an input system constructed in accordance with the principles of the present invention.

FIG. 1B is a block diagram of a second alternative embodiment of the present invention.

FIG. 1C is a block diagram of a third alternative embodiment of the present invention.

FIGS. 2A–B are perspective views of reference apparatus of the present invention.

FIG. 2C is a schematic diagram of the reference apparatus of FIGS. 2A–B.

FIG. 3A is a perspective view of a hand-held pointer or mouse of the present invention.

FIG. 3B is a schematic diagram of the pointer of FIG. 3A.

FIG. 4 is a block diagram of a control circuitry of the present invention.

FIG. 5 is a diagram illustrating an active area within a virtual space which the device of the present invention may operate.

FIGS. 6A–D is a diagram illustrating the positional and attitude information which may be processed and communicated by the device of the present invention.

FIG. 7 is a lateral view of another embodiment of the present invention which includes a head tracker.

FIG. 8 is a diagram illustrating the positional and orientation information which may be processed and communicated by the embodiment of FIG. 7.

FIG. 9 is a lateral view of yet another embodiment of the present invention which includes body tracking apparatus.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to FIG. 1A, an input system **100** of the present invention comprises a control device **10**, a stationary or reference frame **20**, a pointer or mouse device **30**, and a power supply **40**. The control device **10** provides an interface between both stationary frame **20** and pointer or mouse **30** and a host computer **200**. In particular, stationary frame **20** is connected to control device **10** via line **25**, pointer **30** is connected to control device **10** via line **35**, and control device **10**, in turn, is coupled to the host computer **200** via line **15**. Computer **200** provides information, such as a cursor position, to a user through display **250**, which may be a CRT display or other output device. In a preferred embodiment, computer **200** is an IBM or IBM-compatible personal computer (available from International Business Machines, Armonk, N.Y.).

In FIG. 1B, a first alternative embodiment of the present invention is shown. In system **150**, the control device **10** of system **100** has been replaced with a control interface **11**. Specifically, control interface **11**, which may be in the form of a bus card, connects reference member **20** and pointer **30** to the host computer **200** via line **25** and line **35**, respectively. Control interface **11** is directly connectable to host computer **200** by a system bus (e.g., micro-channel, industry standard architecture (ISA), or extended industry standard architecture (EISA) or similar architecture).

In FIG. 1C, a third alternative embodiment of the present invention is shown. System **150'** includes the previously described components of system **150**. In addition, system **150'** includes a plurality of pointing devices, which may be any desired number of pointers. In an exemplary embodiment, the system **150'** includes four pointers **30*a***, **30*b***, **30*c***, **30*d*** which are connected to four interfaces **11*a***, **11*b***, **11*c***, **11*d*** via lines **35*a***, **35*b***, **35*c***, and **35*d***, respectively. The interfaces **11*a***, **11*b***, **11*c***, **11*d*** are interconnected or daisy-chained by intercard umbilical lines **13*a***, **13*b***, **13*c***.

Referring now to FIGS. 2A–B, the stationary or reference frame **20** comprises a frame **26** having a plurality of spaced-apart transmitter sources **21**, **22**, **23** for generating signals which may be detected. In a preferred embodiment, the reference **20** is a transmitting device which includes three ultrasonic transducers (or piezo-electric speakers) capable of producing a short burst of acoustic cycles (e.g., 22.5 kilohertz) when activated.

Those skilled in the art will also appreciate that other sources, e.g., magnetic, electromagnetic, infrared, sonic, infrasonic, and the like, may be detected in accordance with the present invention. The use of ultrasonic transducers is particularly desirable, however, due to their low cost and widespread availability. Furthermore, ultrasonic transmissions are immune to radio frequency (RF) and other electromagnetic interferences which are common in a workplace setting.

As shown in the embodiment of FIG. 2A, reference **20** includes an "L"-shape frame **26** housing the three transducers **21**, **22**, **23** in a right-triangle configuration. Right transducer **23** and vertex transducer **22** are preferably mounted close to the work surface (i.e., table top) and tilted upward from about 20 to 40°, preferably about 25°; top transducer **21** is located directly over vertex transducer **22** and tilted upward at angle of 20° or less. When so configured, the system receives minimum sound reflections (and hence noise) from the work surface.

As shown, reference frame **20** also includes a calibration microphone **24** located a known distance from one of the

speakers for calibrating the speed of sound in air in the user's environment (as described hereinbelow). To simplify the determination, microphone **24** is mounted at a known relative location for calibration with one of the speakers. As shown in the embodiment of FIG. **2A**, microphone **24** is mounted near the top speaker **21** for calibration with the right speaker **23**.

Alternate configurations exist for the reference member. As shown in FIG. 2B, for example, apparatus **40** includes a "T"-shaped frame having three spaced-apart transducers **41, 42, 43** arranged in an equilateral-triangular fashion (i.e., with each transducer at a vertex). Those skilled in the art will appreciate other configurations for the transmitter. For example, each of the transducer elements may be housed within its own independent structure such as that taught by U.S. Pat. No. 4,988,981 (applied to a plurality of receivers). Typically, the transmitter or reference apparatus will be fashioned in a configuration which is suitable for stationary use in the user's work area, e.g., a desk top.

Referring now to FIG. 2C, a schematic of the transmitting reference **20** is shown. Each of the elements **21, 22, 23** comprises a piezo-electric transducer or speaker having separate input/output lines. Calibration microphone **24** is also provided with separate input/out lines. All lines are combined into the single line **25** which is connected to the control interface **10** (or **11**).

Pointer **30**, in contrast to the stationary reference transmitter, is a highly mobile device which may be held or worn by the user. In the embodiment of FIG. 3A, pointer **30** is a mouse or hand-held pointing device which includes a housing **37** having a plurality of user keys **36** and a plurality of detecting elements **31, 32, 33**. Housing **37** is constructed of light-weight materials, such as plastics, and is fashioned into a shape which conforms to a user's hand.

As shown, mouse **30** includes user-activated switches or keys **36** disposed along the top or dorsal surface of housing **37**, thus placing the keys at or near where a user's fingertips will lie. Keys **36** operate as switches or buttons which allow the user to communicate with the computer **200**. Specifically, when activated by the user (e.g., by depressing with a finger), each key **36** transmits a signal to the host computer **200**, which may then be acted upon by application and/or system software. Each signal may be predefined or user defined to emulate user functions or key strokes. Each key or pointer button can be actuated independently or in any combination with other key(s). Additional signals may be generated by the keys **36** using "double clicking" and "dragging" (click and holding) techniques, which are known in the art.

In a preferred embodiment, keys **36** includes at least five mouse buttons, with three buttons emulating a Logitech three-button mouse and two supporting additional input (e.g., "continue" and "suspend" described hereinbelow). Alternatively (in the same or an alternate embodiment), two of the keys **36** provide Microsoft mouse emulation. Signals generated by the key(s) are communicated to control device **10** (or control interface **11**) via line **35**. Techniques for transmitting and receiving signals from mouse buttons, such as the keys **36**, are known in the art; see, e.g., *Microsoft Mouse Programmer's Reference*, Microsoft Press, 1989.

Offered for purposes of illustration and not limitation, apparatus and techniques for transmitting and receiving mouse data ("mouse record"), including both key and motion signals, are presented in Appendix A. Additional apparatus and techniques, including methods for transmitting and receiving attitudinal orientation information in accordance with the present invention, are presented in Appendix B.

The pointer or mouse **30** also includes detecting elements **31, 32, 33** in the form of microphones for receiving acoustic signals from the reference frame **20**, as well as for receiving speech, voice commands, and/or other sound input from the user. In a preferred embodiment, mouse microphones **31, 32, 33** are three omni-directional microphones which are disposed on the housing **37** in an equilateral-triangular fashion (i.e., so that no one angle exceeds 90°). While omni-directional, each microphone should have an unobstructed "line of sight" or view of the reference **20** when the pointer **30** when held in the user's hand. When used for audio input (e.g., for push-to-talk operation, described hereinbelow), one or more microphones will be aimed in the general direction of the audio source, such as the user's mouth.

As shown in the embodiment of FIG. 3A, microphones **31, 32, 33** may be disposed substantially along one face, e.g., a forward or anterior face, of the mouse **30**. To improve detection of the transducer sources, however, the three microphones are not arranged co-linear in a preferred embodiment. As illustrated, microphone **32** is offset from the other two microphones, which lie substantially co-planar with the top of the housing **37**, so that an equilateral triangle lying in a vertical plane is defined by the three microphone elements **31, 32, 33**. In a preferred embodiment, the three microphones **31, 32, 33** will lie in a vertical plane when the mouse **30** is at rest (e.g., on a desk top), thus simplifying the calculation of mouse information (described in further detail hereinbelow).

Referring to FIG. 3B, a schematic diagram of the mouse **30** is shown. Keys **36** comprise a plurality of switches, such as switches **36***a–e*. By providing each switch with a resistor (e.g., R_{1-5}) which has a unique resistance and which provides a unique sum resistance when added to others resistors, various combinations of keys or switches **36** may be determined. As shown, one switch (e.g., switch **36***e*) may serve as a master switch. Also shown in FIG. 3B, are the microphones **31, 32, 33**, each having separate input and output lines. One of the microphone elements (or more), such as microphone **31**, may also be coupled to the switches (e.g., by a ground line) for switch-activation of that element. All input/output lines of the keys **36** and microphone elements **31, 32, 33** are combined into the single line **35**, which may be connected to the interface **10** (or **11**).

While the foregoing discussion of the reference and pointing components of the present invention presents a stationary transmitting reference and a moveable receiving pointer, those skilled in the art will readily appreciate that the stationary reference may instead include detectors or receivers (e.g., microphone disposed on a stationary desktop frame) while the pointer is a mobile transmitter device (e.g., a pointing device having transducers). In this alternate configuration, elements **31, 32, 33** of pointer **30** are instead three spaced-apart transmitters, such as ultrasonic transducers. In this case, elements **21, 22, 23** of frame **20** (or elements **41, 42, 43** of frame **40**) are three spaced-apart detectors, such as omni-directional microphones. With either configuration, the system **100** can accurately determine the position and attitude of pointer **30** relative to stationary reference **20**.

The operation of system **100** will now be described. In the following discussion, stationary device **20** will serve as the transmitting member, and the pointing device or mouse **30** will function as the receiving member. Those skilled in the art will appreciate the operation of the complimentary configuration, i.e., system **100** with stationary device **20** serving as the receiving member and the pointer **30** as the transmitting member. Furthermore, the discussion of operation of system **100** is also applicable to system **150** and **150'**.

In operation, system **100** uses the propagation delay of sound to perform position determinations. In particular, the system **100** measures the time of delay for sound to travel from each of the three speakers **21**, **22**, **23** to the three microphone elements **31**, **32**, **33** positioned on mouse **30**. From this delay information and the speed of sound in air (calibrated for that time and location), input system **100** (or **150**) determines the position and attitude of the mouse **30** with respect to the transmitter apparatus **20**.

Referring now to FIG. **4**, the function and construction of control interface **11** will be described. (Interface **10** operates in a like manner but communicates with computer **200** through a communication port, e.g., a RS232 or SCSI, instead.) Control interface **11** provides apparatus and method for accurately measuring the distance from a speaker (e.g., speakers **21**, **22**, **23**) to a microphone (e.g., mouse microphones **31**, **32**, **33** or transducer microphone **24**).

As shown, control interface **11** interacts with reference **20**, pointer **30**, and a device driver **210** stored in host computer **200**. During power on, interface **11** or **10**, under control of driver **210**, initializes and enables mouse **30**, transducer **20**, and control interface **11**. Next, the first of three speakers (e.g., transducers **21**, **22**, **23**) is selected. Control interface **11** measures the time required for sound to propagate to each of the three microphones(e.g., microphones **31**, **32**, **33**). When sound is detected, a software interrupt is generated by apparatus **11** which may be read by the driver **210**. Driver **210**, which may be a software device driver or firmware (e.g., ROM, EPROM, or the like), reads the generated interrupt and the timer values for each of the four microphone elements (e.g., calibration microphone and three mouse microphones). The process is then repeated for each of the remaining speakers, with the driver **210** computing the current speed of sound and the position and attitude of the pointer or mouse. This information, in turn, is provided to computer **200** for use by application and/or operating system programs.

Control interface **11** comprises timers **51**, pulse detectors **52**, processor **53**, bus interface **54**, configuration status **55**, decoder **56**, sequencer **57**, and speaker driver **58** and audio out **59**. Connection to computer **200** is through bus interface **54**, which includes a 8/16-bit bus adapter as is known in the art. Interface **54** may occupy one of the selectable device locations (e.g., serial ports COM1–COM4, or parallel ports LPT1–LPT2), with the associated device interrupt request (IRQ) provided by sequence **57** (e.g., by user-selectable jumper). For a general discussion of device locations, device drivers, and software/hardware interrupts in an IBM Personal Computer, see *IBM Technical Reference* (International Business Machines, Armonk, N.Y.), or Programmer's Guide to the IBM PC, Microsoft Press, 1985.

In operation, control interface **11** stimulates each speaker element and starts a counter for each of the microphones. Particularly, driver **58** under control of the speaker driver **58** stimulates transducers **20**. Processor **53** "listens" for the sound from the speaker to arrive at each microphone **30**; each counter or timer **51** is stopped when a particular sound is detected at its corresponding microphone. Since the speed of sound in air varies with environment (according to ambient temperature and barometer pressure), the control interface **11** measures the current speed of sound each time the position of the pointer or mouse **30** is calculated. By measuring the amount of time required for sound to travel a known fixed distance (e.g., between speaker **23** and microphone **24**), the speed of sound may be determined.

Bus interface **54** is connected to the configuration/status registers **55** and to two timer chips **51**, each of which contains three sixteen-bit timers. At any one time, only one of the two timers is selected as active (by setting a corresponding bit in the configuration register **55**). Bus interface **54** also includes an eight-bit data bus buffer and a sixteen-bit address decoder. An equality comparator is provided to detect the address bits which do not change based upon jumper selection. A GAL chip is used to decode the remaining address bits based upon jumper selection.

Timers **51** includes a pair of 82C54 timer chips (available from Intel Corporation of Santa Clara, Calif.) which provide timers for the four microphones and clocking for the speaker drivers; timing sequence is provided by sequencer **57**. In a preferred embodiment, the timers **51** include clock rates up to 10 megahertz.

Control sequencer **57** is provided by a GAL Chip (such as a GAL 16V8A chip available from Lattice Semiconductor Corporation of Hillsboro, Oreg.) which is responsible for providing timing sequence. The GAL can track many pointer devices in front of one transducer frame. The GAL also provides the "sample" and "dump" signals used by analog processing **52**.

Control **10** and **11** also receives and processes the signals from keys **36**. In turn, the signals are provided to computer **200** through interface **54**. In addition, processor supplies audio information (from the mouse **30**) to audio out **59**, which may be in the form of a standard DIN jack. Alternatively, audio may be supplied to the computer **200** through interface **54**.

The operation of control **10** and **11** are set forth in further detail in Appendix C. Moreover, a method for determining position and attitudinal information from a pointing device in 3-D space is disclosed in co-pending application Ser. No. 07/601,942, now assigned to the assignee of the present case, the disclosure of which is hereby incorporated by reference.

User operation of system **100** will now be described. System **100** provides two-dimensional and three-dimensional operating modes. In the two-dimensional or "2D" operating mode, the mouse **30** operates as a conventional mouse, reporting two-dimensional positions on a desk top plane; in this mode, the mouse **30** is compatible with Logitech (Fremont, Calif.) and Microsoft (Redmond, Wash.) pointing devices. The "6D" mode, the alternative mode, permits six degrees of freedom (i.e., reporting three-dimensional positions with three rotational orientations within a three-dimensional space).

Referring now to FIG. **5**, the "6D" mode is illustrated. The mode provides three-dimensional (X, Y, Z) positional information and attitude information, including pitch, yaw, and roll. As shown, the X, Y, Z rectangular (Cartesian) coordinate system is used as the three-dimensional coordinate system of a preferred embodiment.

A zone or "active area", shown as Space A, is provided in front of reference **20** in which pointer **30** may move. The active area A is the zone or space in which maximum tracking resolutions (e.g., 400 dpi) are maintained. Movement outside the active area A, causes the pointer **30** to enter a fringe area B. Movement of the pointer **30** within the fringe area B is still tracked by the system **100**, but at a lower resolution. Movement of the pointer **30** outside of the fringe area B (i.e., into space C) is clipped.

Visual feedback of movement within the different zones may be provided by displaying differently shaped or colored cursor icons on the display **250**. For example, while the pointer **30** is within the active area A, a green cursor may be displayed. When the pointer **30** moves into the fringe area B,

a yellow cursor may be displayed. Movement of the pointer **30** into the clipped zone C, causes a red cursor to be displayed. By analogy, space A resembles the normal playing area of a baseball diamond, zone B is similar to the warning track in baseball, and zone C serves as a fence, beyond which no action can be taken.

In one embodiment, the active area includes a cube of approximately two feet in width, with an additional 8 inch fringe area; the center of the cube is the origin of space for the mouse, leaving one foot of high-resolution tracking in each direction (x, y, and z). In an alternate embodiment (e.g., system **300** discussed hereinbelow), the active area includes a seven-foot cube. Those skilled in the art will appreciate that other "active areas," having different sizes and/or configurations, may be provided.

Referring now to FIGS. 6A–D, the tracking and representation of attitude or rotational information of the present invention will now be described. Rotation is defined as follows:

1) Pitch is rotation about the X axis.

2) Yaw is rotation about the Y axis.

3) Roll is rotation about the Z axis.

Positive directions are defined by the right-hand rule (indicated by corresponding arrows). As shown in FIGS. 6B–D, 6D-mode information may be processed by computer **200** for display to the user via display **250**.

The orientation for rotation may be relative to the pointer or to the reference frame; alternatively, the orientation may be global. When relative to the mouse (i.e., Local Euler mode), rotations are determined from the mouse's viewpoint. If the user points the mouse directly at the transducer and rocks one of its ends up and down (i.e., changes the mouse's angular relation to its X axis), the user is affecting the pitch angle. If the user then rotates the mouse 90 degrees to the right and then rocks it up and down, the user is affecting the yaw angle (not the pitch angle). In this mode, the orientation of the mouse **30** duplicates that of a pilot in an aircraft. When a pilot is flying a plane upside down and pushes the control stick forward, for example, the pilot wishes to go "down" from his or her perspective (which is actually "up" relative to the horizon).

Further description of the local Euler mode and other orientation modes (including Global Euler and Quaternions modes) is set forth in Appendix B, at pages 15–17.

Besides receiving positional (and in the case of 6D mode, attitude information), system **100** also receives user input from keys **36**. In a preferred embodiment, at least one signal of the keys **36** will cause continuation of the current mouse movement. If the user is moving the mouse **30** forward, for example, the user may activate a key for continuing this forward movement regardless of how the mouse itself now moves. The continuing function may be applied to position movements, rotations, or both. The direction to continue may be determined to be the same direction as the mouse is facing (i.e., the mouse's viewpoint). Alternatively, the direction may be determined from a vector constructed from the last two mouse samples, or constructed from an average of a selected number of mouse samples. The "continue" function operates in either 2D or 6D mode.

Complementing the "continue" key, in a preferred embodiment, at least one signal of the keys **36** will cause reversal of the current mouse movement. If the user is moving the mouse **30** forward, for example, the user may activate a "backward" key for continuing the movement in a reverse direction, regardless of how the mouse itself now moves.

Despite having a finite "active area" in which to move a pointer device, system **100** also provides the user a method and apparatus for traversing large virtual or screen distances. Unlike conventional 2-D mice, a 3-D mouse cannot be simply "stroked" on a desk top for traversing large screen distances (as described in the Background). According to the present invention, at least one of the signals of keys **36** includes a "suspend" apparatus for ignoring position movements, rotations, or both. Thus, mouse **30** may be repeatedly "stroked" across the active area, with the suspend apparatus invoked during the back stroke phase. In effect, mouse **30** may be moved large virtual distances regardless of the size of the active area. The "suspend" function operates in either the 2D or 6D mode.

Also, keys **36** activate a "push-to-talk" feature. In particular, at least one signal of the keys **36** will activate a mouse microphone (e.g., microphone **31**, microphone **32**, and/or microphone **33**) to receive audio input from the user. The operation of the key may resemble that of a dictation machine, with audio received in response to one signal and halted in response to another signal; alternatively, one signal may serve as a toggle.

The push-to-talk feature is particularly advantageous when used with voice recognition and multimedia applications. If more than one mouse microphone is activated, stereo audio input may be received by the mouse **30**. Audio input received by the mouse is supplied to the control interface **11**, and in turn supplied to the computer **200** and/or the audio out **59** (of FIG. **4**).

In a preferred embodiment, the "push-to-talk" feature is operably coupled to the "suspend" feature as follows. Activating the push-to-talk signal or mode also invokes the suspend mode. In operation, as the computer **200** is executing an application, such as a multimedia application, the user may invoke press-to-talk for entering audio input, while at the same time suspending or freezing other input (e.g., graphic input).

The continuing, suspend, and push-to-talk functions may be controlled by the device driver **210**. In response to a continue signal from keys **36**, for example, driver **210** continues to supply current mouse information to computer **200**. In response to a suspend signal from keys **36**, on the other hand, driver **210** temporarily suppresses the transmittal of mouse information to computer **200**. similarly, driver **210** provides audio input depending on the status of the push-to-talk button.

Referring now to FIG. **7–8**, an alternative embodiment of the present invention is described. In particular, an embodiment is provided in which other body parts (e.g., head), in addition to hands, are used for input. Input device **300** includes a head tracker **330** for receiving acoustic signals from transducer **320** which is coupled to computer **200** (and display **250**) through line **325**. Head tracker **330** includes a plurality of microphone elements, such as the three omni-directional microphones of mouse **30**. As shown, tracker **330** may be worn like a hat, with the microphone elements substantially facing upward. In this embodiment, tracker **330** may include a display (e.g., LCD or CRT display **250**) positioned within the user's field of view.

The transmitter apparatus **320** includes at least three ultrasonic transducers with a calibration microphone, such as those described for the transmitter apparatus **20**. Apparatus **320** is placed in a stationary position relative to the user's head. As shown in the embodiment of FIGS. **7–8**, apparatus **320** may be suspended above the user for tracking positional and rotational movement of the user's head. Thus, rotation of the user's head along the Y axis, e.g., by spinning

in a swivel chair, is yaw rotation. Rotation of the user's head along the X axis, e.g., by nodding side to side, is pitch rotation. Rotation of the user's head along the Z axis, e.g., by nodding back and forth, is roll rotation. Alternative orientations (e.g., as set forth in Appendix B) may be employed.

In an alternative embodiment, the tracker may be disposed along the face of a user, for example, in the form of eyeglasses having three microphone elements. In this case, the transmitter apparatus will be positioned in front of the user (e.g., as shown in FIG. 5).

While the foregoing embodiments (e.g., devices **100**, **150**, **300**) have been described with reference to tracking a single pointer or mouse in space, the present invention (particularly, system **150'**) is also capable of tracking multiple pointers in space with a single transducer frame. As shown in FIG. **9**, for example, microphone apparatus may be placed on the user's head **500**, e.g., head tracker **330**, as well as on each arm, e.g., hand trackers **331**, **332**. Each tracker includes at least three microphone elements (e.g., elements **31**, **32**, **33**) for receiving acoustic signals from the transducer **320**. Other body parts may be tracked by placing tracking or pointing member accordingly.

This may be used advantageously in computer-aided design applications where an operator may select objects on a display (virtual environment) independent of overall movement. Thus, the user may move or navigate within a virtual space (virtual reality applications) using the head tracker **330** while hand trackers **331**, **333** are used to effect operations, such as manipulating objects, within that space.

While the invention is described in some detail with specific reference to a preferred embodiment and certain alternatives, there is no intent to limit the invention to that particular embodiment or those specific alternatives. Those skilled in the art, for example, will appreciate that other transmitted signals, such as infrared, radiowaves, and the like, may be employed for detection. The true scope of the invention is defined not by the foregoing description but by the following claims.

What is claimed is:

1. A hand-held pointer system for a computer having a display comprising:

a transmitter for transmitting signals from a stationary location;

a pointer including three receivers for receiving said transmitted signals;

a hand-held housing incorporating said pointer, said housing being movable in 3D space and rotatable about x, y and z axes;

a control circuit, operably coupled to the transmitter and the pointer for providing the computer a position of said pointer relative to said stationary location and an attitude corresponding to each of the x, y and z rotation of said housing, whereby a position indicator on said display is altered in accordance with said position and said attitude, both said position and said attitude being determined from the signals from said three receivers;

an output port of said pointer for coupling to an input port of a computer, said output port including a plurality of analog control lines;

a plurality of switches;

a plurality of impedances, each impedance coupled to one of said switches to form a combination of a switch and an impedance;

a plurality of the combinations of a switch and an impedance being coupled to one of said analog control lines;

at least a first user input button, mounted on said hand-held housing and coupled to at least one of said switches;

whereby an actuation of different ones of said switches provides different signal levels on said control line indicating which switches are actuated;

means in said computer for interpreting said different signal levels to modify the display of said cursor or viewpoint;

a second user input button;

means, operably coupled to the second user input button, for suspending the sending of position information in response to a signal from said second user input button;

means for resuming the sending of position information in response to a second signal from said second user input button, after movement of said pointer, whereby a position indicator on said display is frozen in accordance with said suspending, and resumes from the frozen position in response to said resuming, regardless of the actual position of said pointer at the time of resuming;

a third user input button;

a microphone mounted in said pointing device, operably coupled to the third user input button for receiving audible audio input in response to a signal from said third user input button;

wherein said microphone in the absence of said signal from said third user input button receives ultrasonic position information; and

means for suspending the sending of position information from said microphone to said computer in response to said signal from said third user input button.

* * * * *

US006001014A

United States Patent [19]

Ogata et al.

[11] Patent Number: 6,001,014

[45] Date of Patent: Dec. 14, 1999

[54] GAME MACHINE CONTROL MODULE AND GAME MACHINE

[75] Inventors: **Hiroki Ogata**, Chiba; **Toru Akazawa**, Tokyo; **Akihisa Ono**, Tokyo; **Satoshi Shinohara**, Tokyo, all of Japan

[73] Assignee: **Sony Computer Entertainment Inc.**, Tokyo, Japan

[21] Appl. No.: **08/940,238**

[22] Filed: **Sep. 30, 1997**

[30] **Foreign Application Priority Data**

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Apr. 22, 1997	[JP]	Japan	9-118729

[51] **Int. Cl.**[6] **A63F 9/22**

[52] **U.S. Cl.** **463/37**

[58] **Field of Search** ..... 463/37, 36, 38, 463/39, 30, 33; 273/148 B; 345/168, 169

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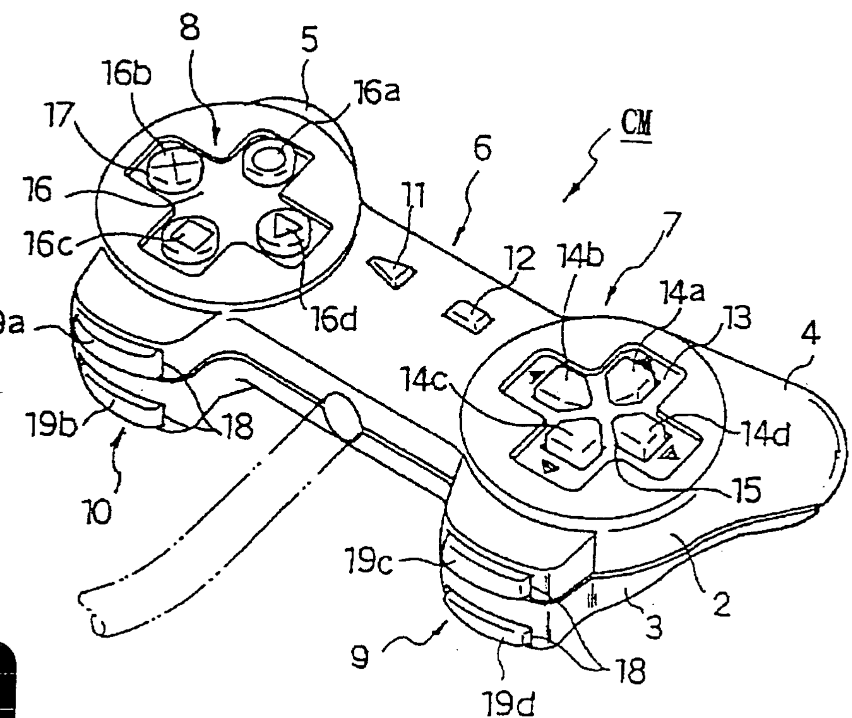
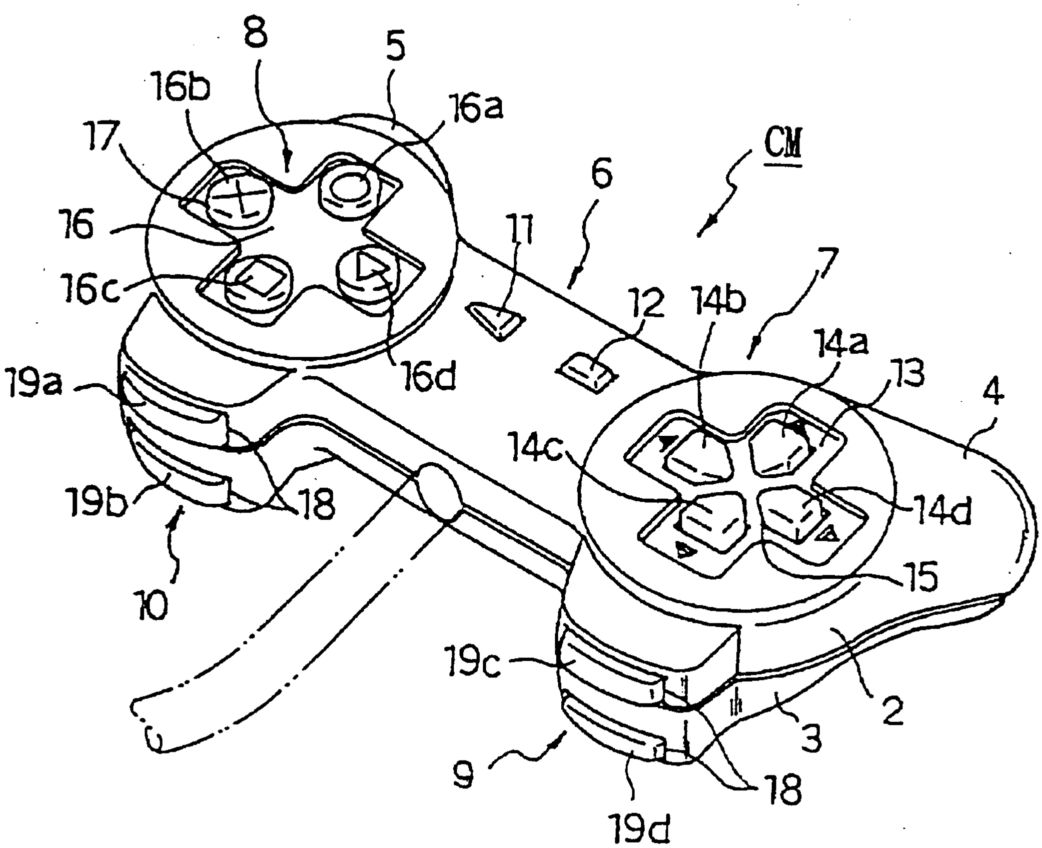
Primary Examiner—Valencia Martin-Wallace
Assistant Examiner—Sheila Clayton
Attorney, Agent, or Firm—Fulwider Patton Lee & Utecht, LLP

[57] **ABSTRACT**

This invention relates to a home game machine, and more particularly, to a game machine control module having a plurality of operation buttons, which is connected to a game machine body through a cable. The game machine control module comprises a control member for transmitting the operation data obtained by a plurality of operation buttons through the cable to the game machine body and for receiving the data from the game machine body through the cable, and a response member positioned at a predetermined place on the game machine control module and controlled by the control member based on a predetermined dynamic transmission data which is contained in the data transmitted from the game machine body. Therefore, this makes it possible to enjoy games giving the feeling of being at a live performance comparing to the conventional one.

36 Claims, 54 Drawing Sheets

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16b
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6
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16c
12
14b
7
14a
13
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14c
14d
19b
18
10
15
19c
2
3
9
18
19d

FIG. 1

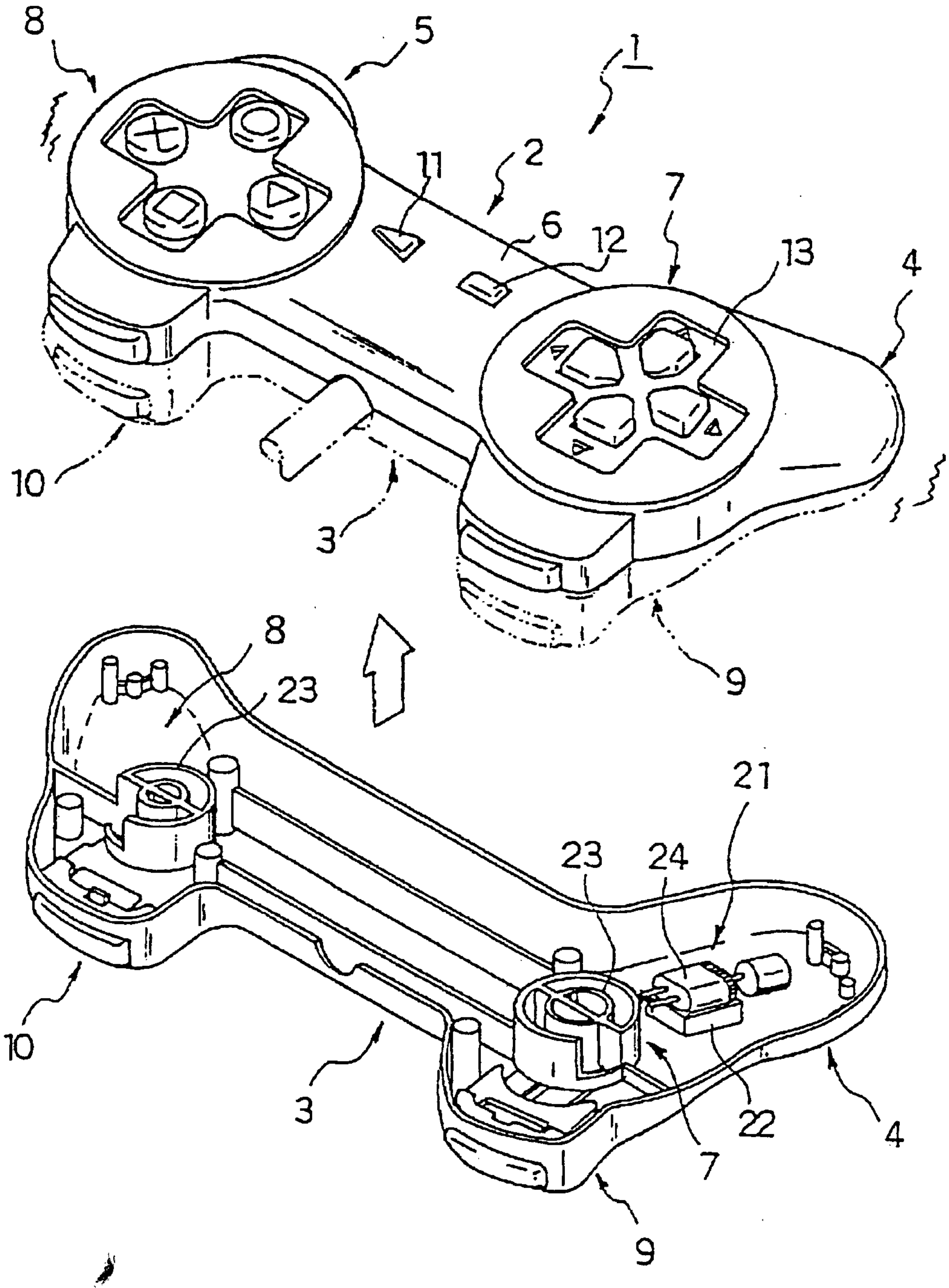


FIG. 2

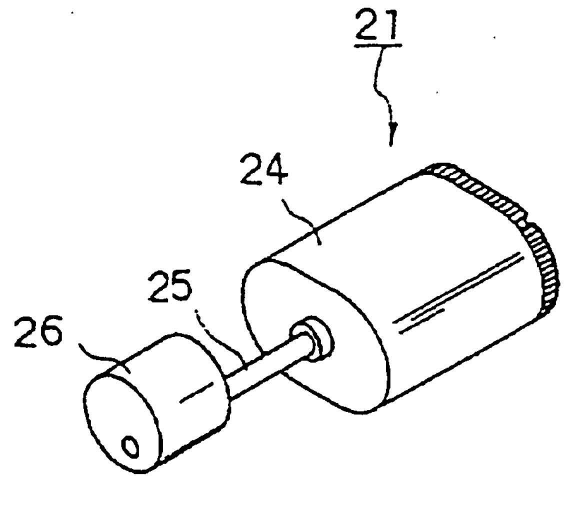


FIG. 3

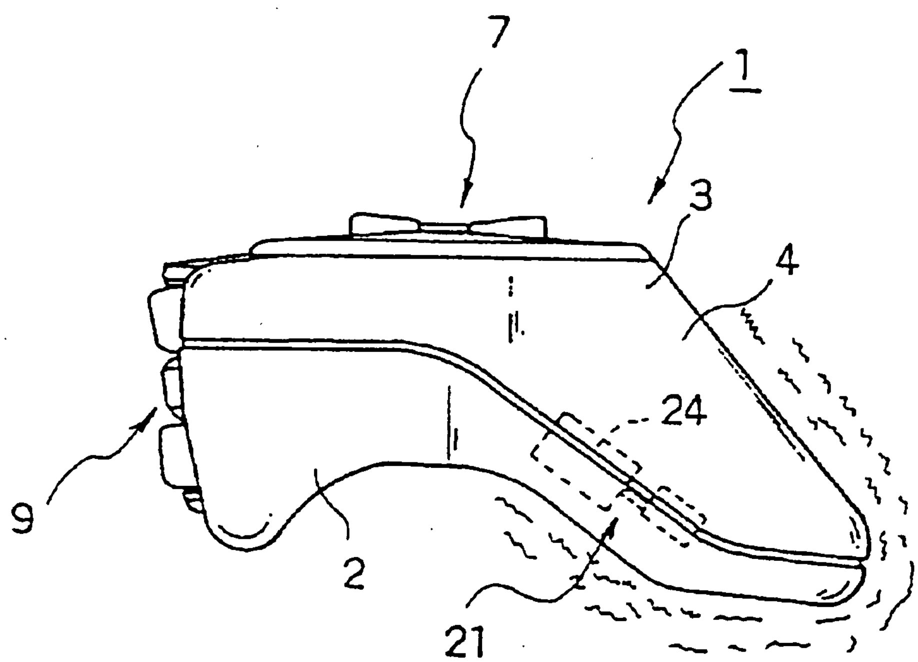


FIG. 4

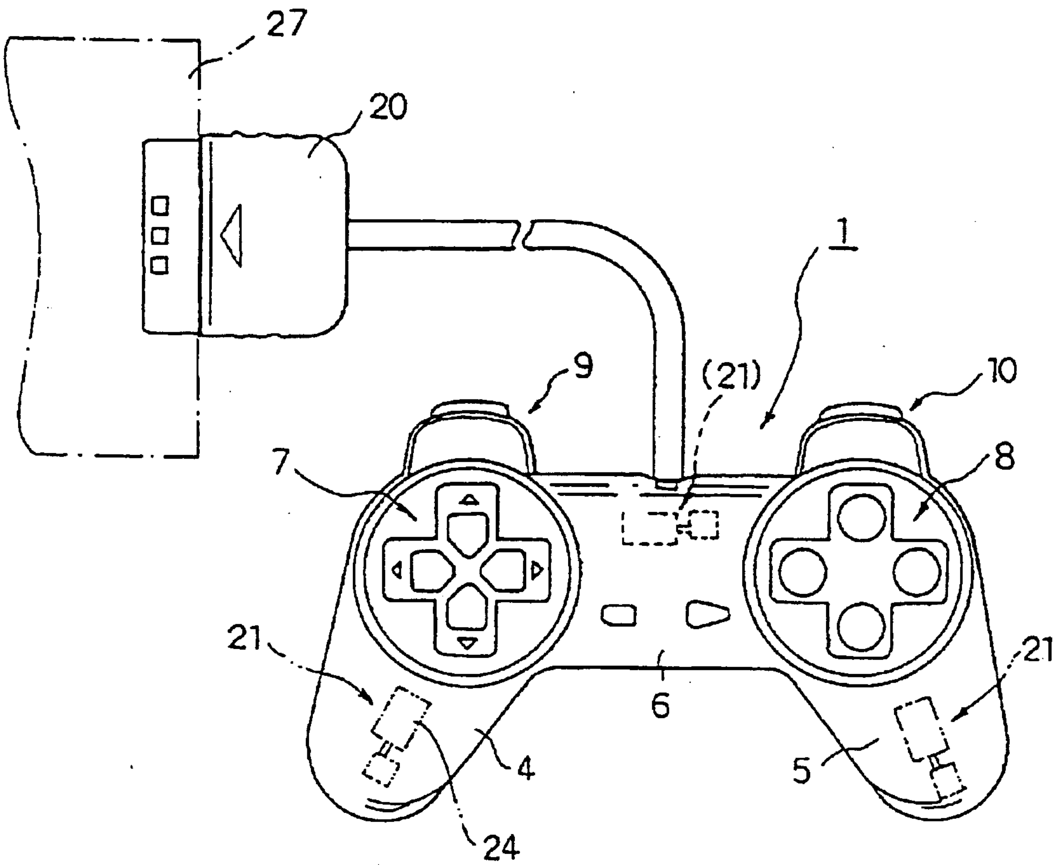


FIG. 5

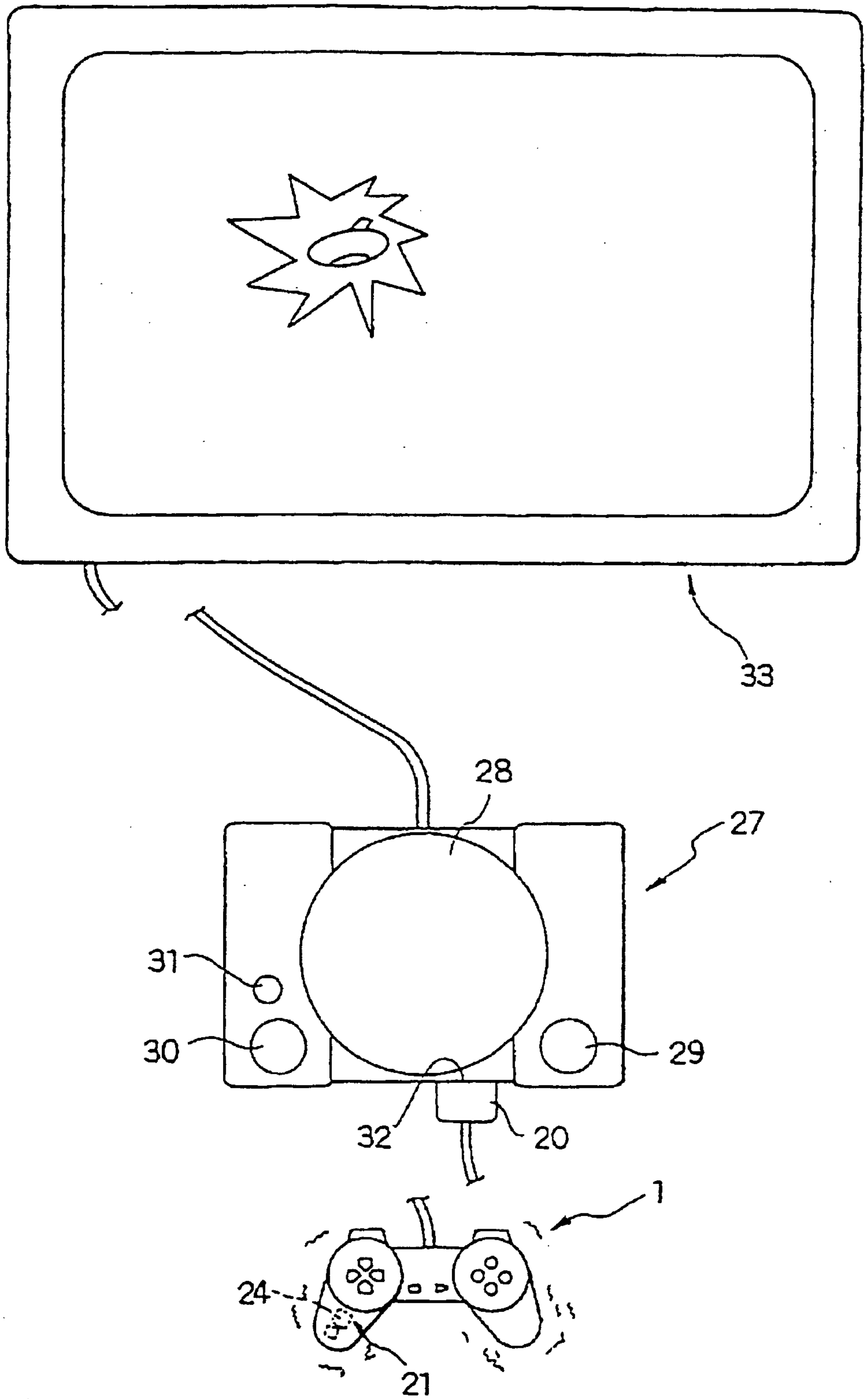
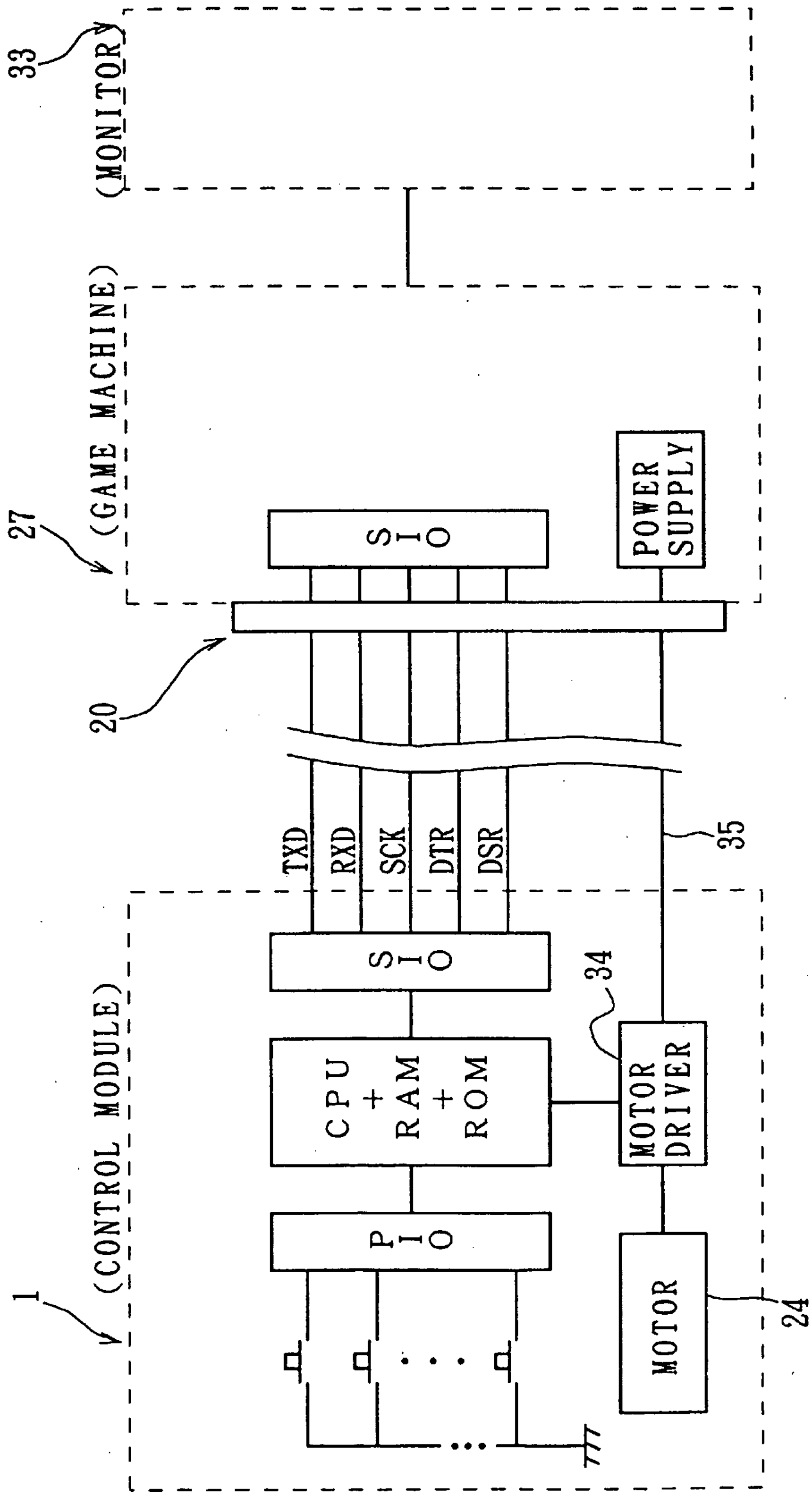


FIG. 6



33
(MONITOR)
27
(GAME MACHINE)
SIO
POWER SUPPLY
20
TXD
RXD
SCK
DTR
DSR
35
1
(CONTROL MODULE)
SIO
CPU + RAM + ROM
PIO
34
MOTOR DRIVER
MOTOR
24

FIG. 7

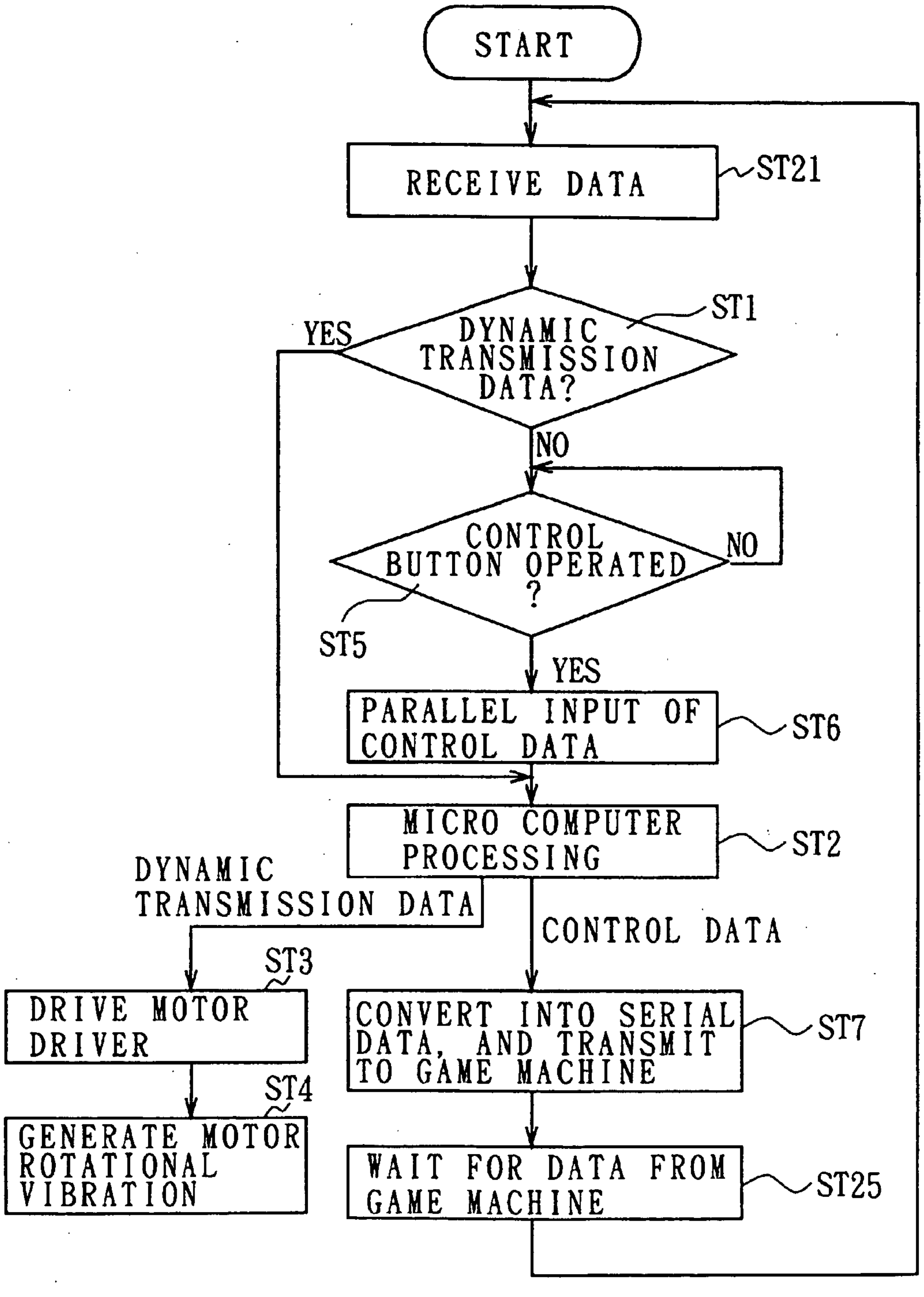

START
RECEIVE DATA
ST21
DYNAMIC TRANSMISSION DATA?
ST1
YES
NO
CONTROL BUTTON OPERATED ?
NO
ST5
YES
PARALLEL INPUT OF CONTROL DATA
ST6
MICRO COMPUTER PROCESSING
ST2
DYNAMIC TRANSMISSION DATA
CONTROL DATA
ST3
DRIVE MOTOR DRIVER
ST4
GENERATE MOTOR ROTATIONAL VIBRATION
CONVERT INTO SERIAL DATA, AND TRANSMIT TO GAME MACHINE
ST7
WAIT FOR DATA FROM GAME MACHINE
ST25

FIG. 8

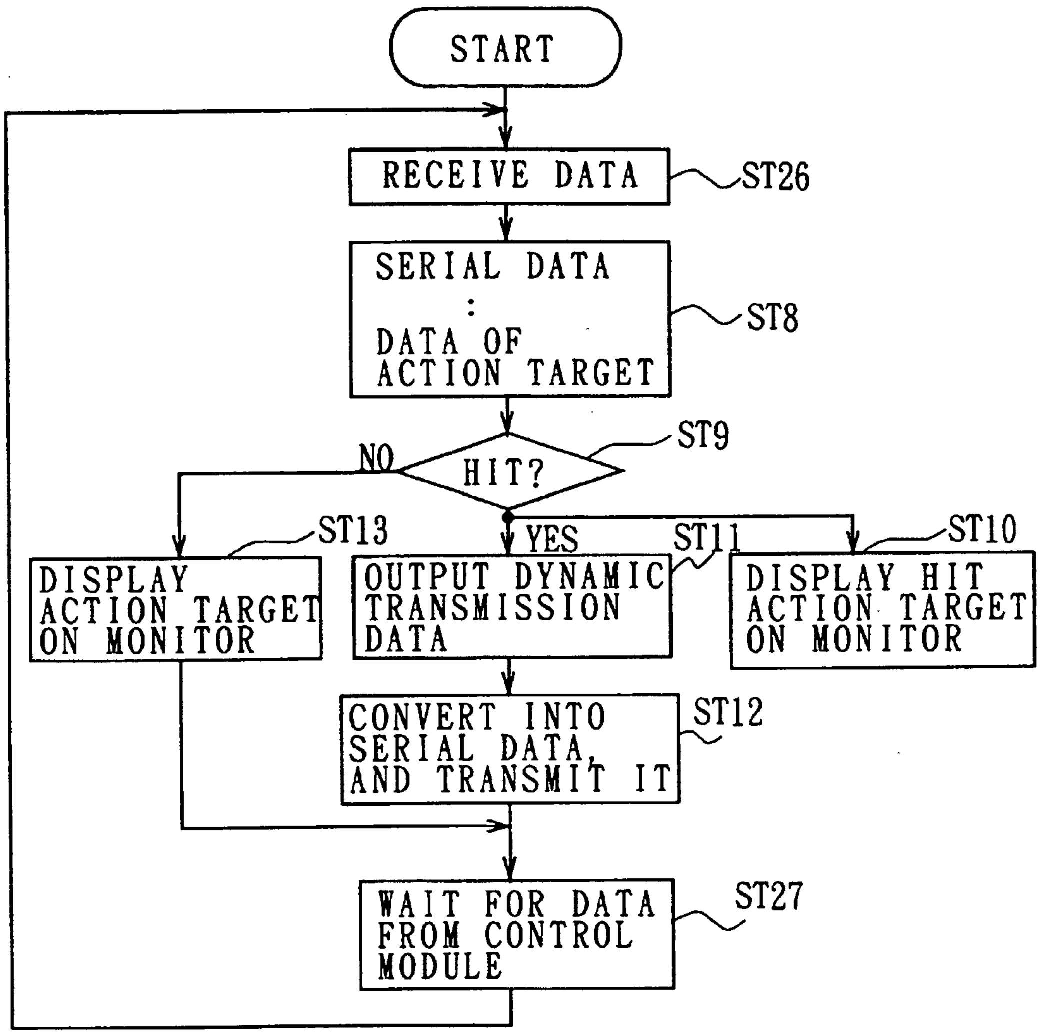

START
RECEIVE DATA
ST26
SERIAL DATA
:
DATA OF ACTION TARGET
ST8
HIT?
ST9
NO
YES
DISPLAY ACTION TARGET ON MONITOR
ST13
OUTPUT DYNAMIC TRANSMISSION DATA
ST11
DISPLAY HIT ACTION TARGET ON MONITOR
ST10
CONVERT INTO SERIAL DATA, AND TRANSMIT IT
ST12
WAIT FOR DATA FROM CONTROL MODULE
ST27

FIG. 9

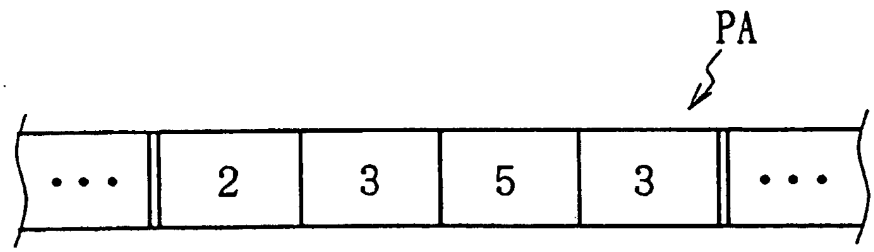


FIG. 10A

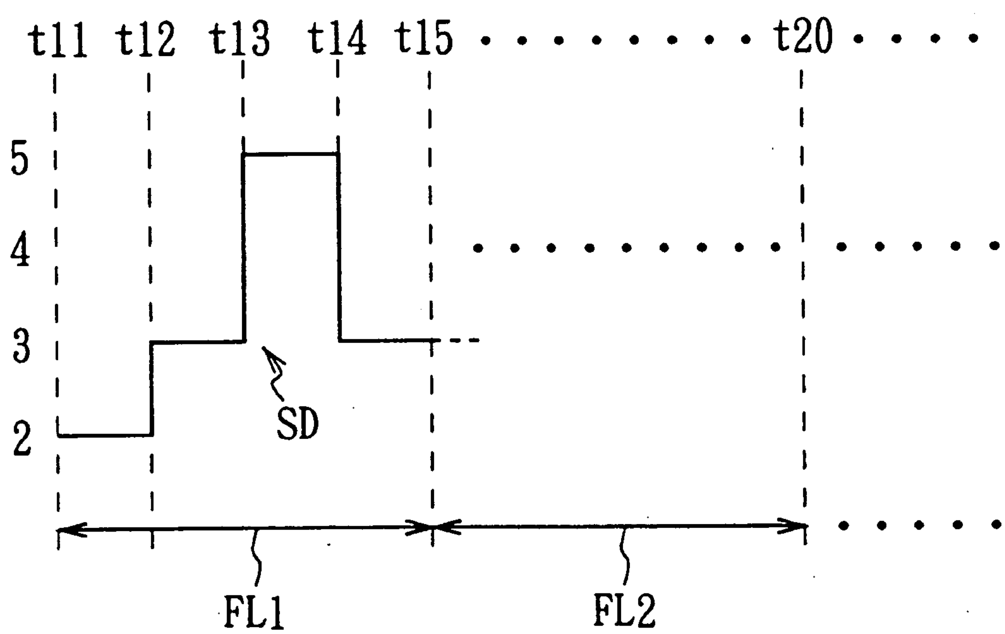


FIG. 10B

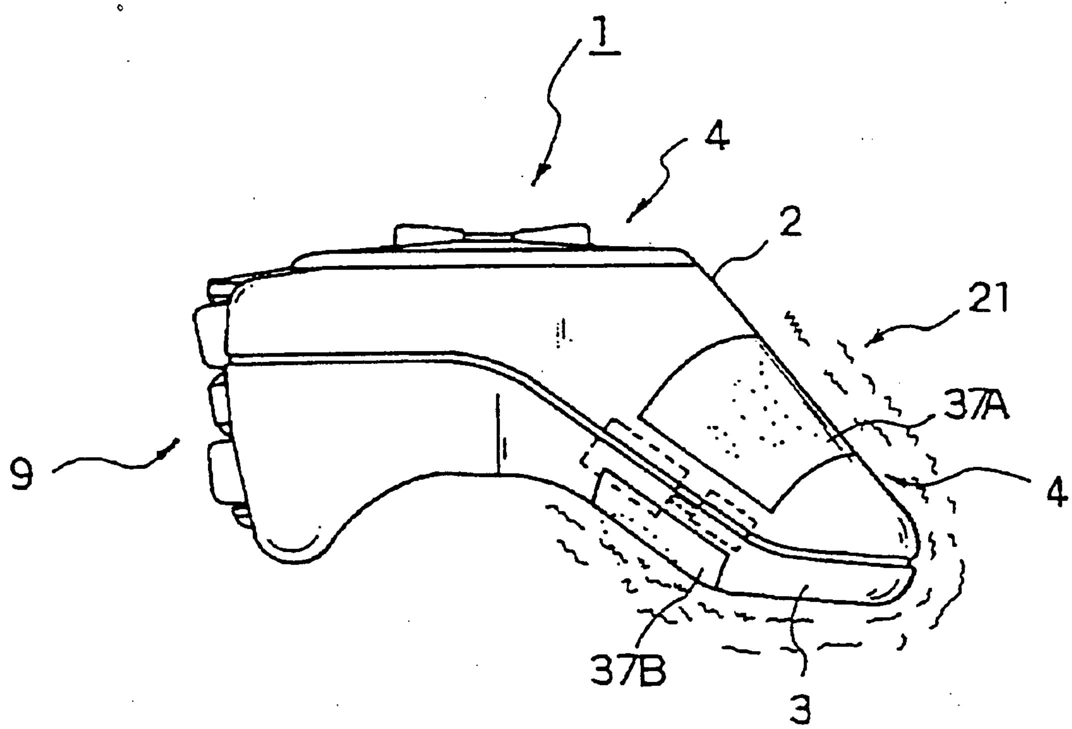


FIG. 11

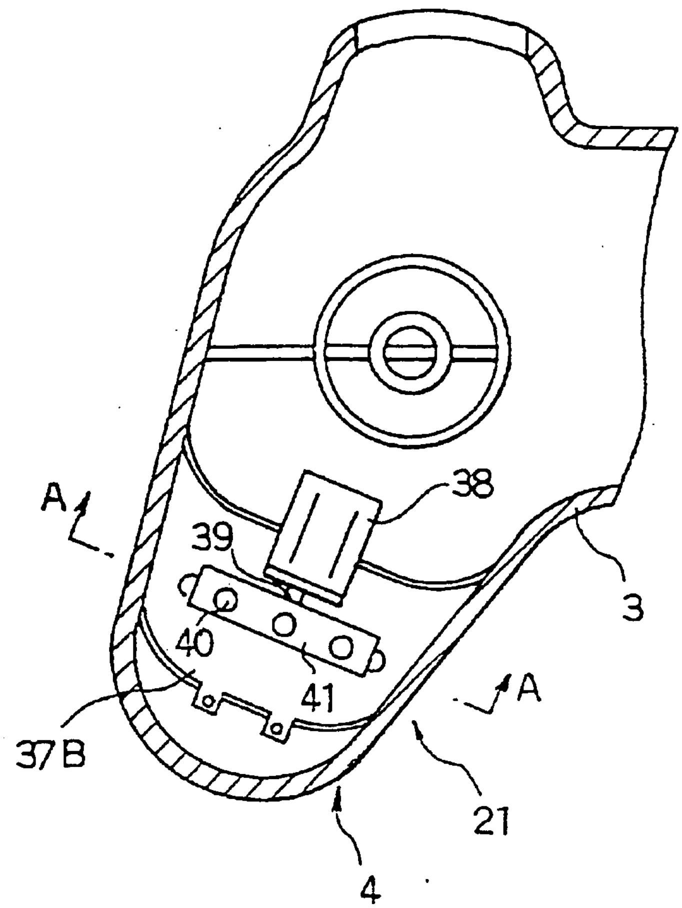


FIG. 12

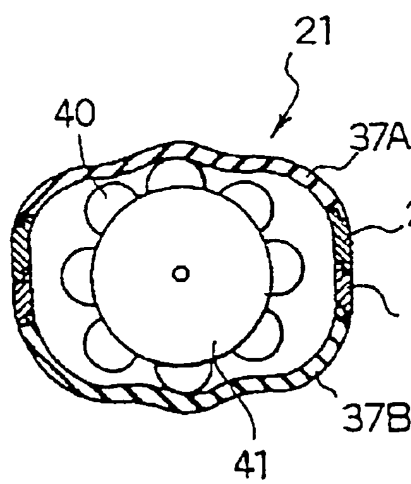


FIG. 13

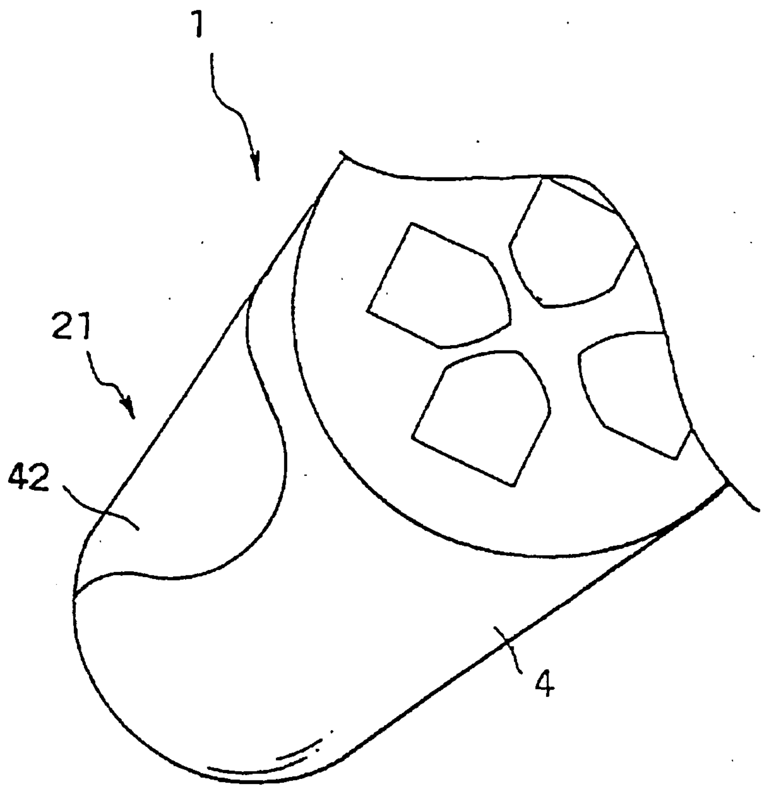


FIG. 14

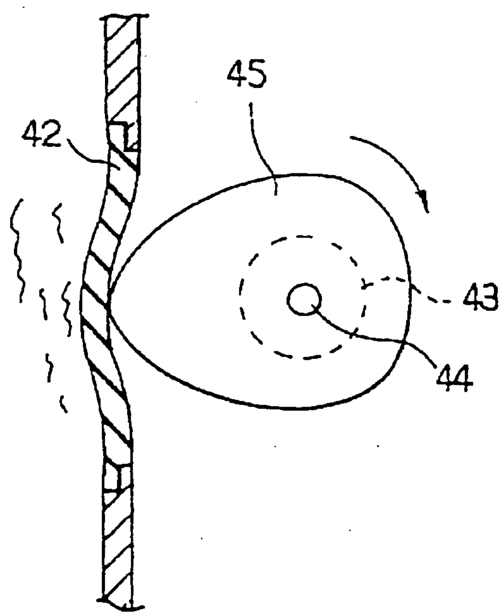


FIG. 15

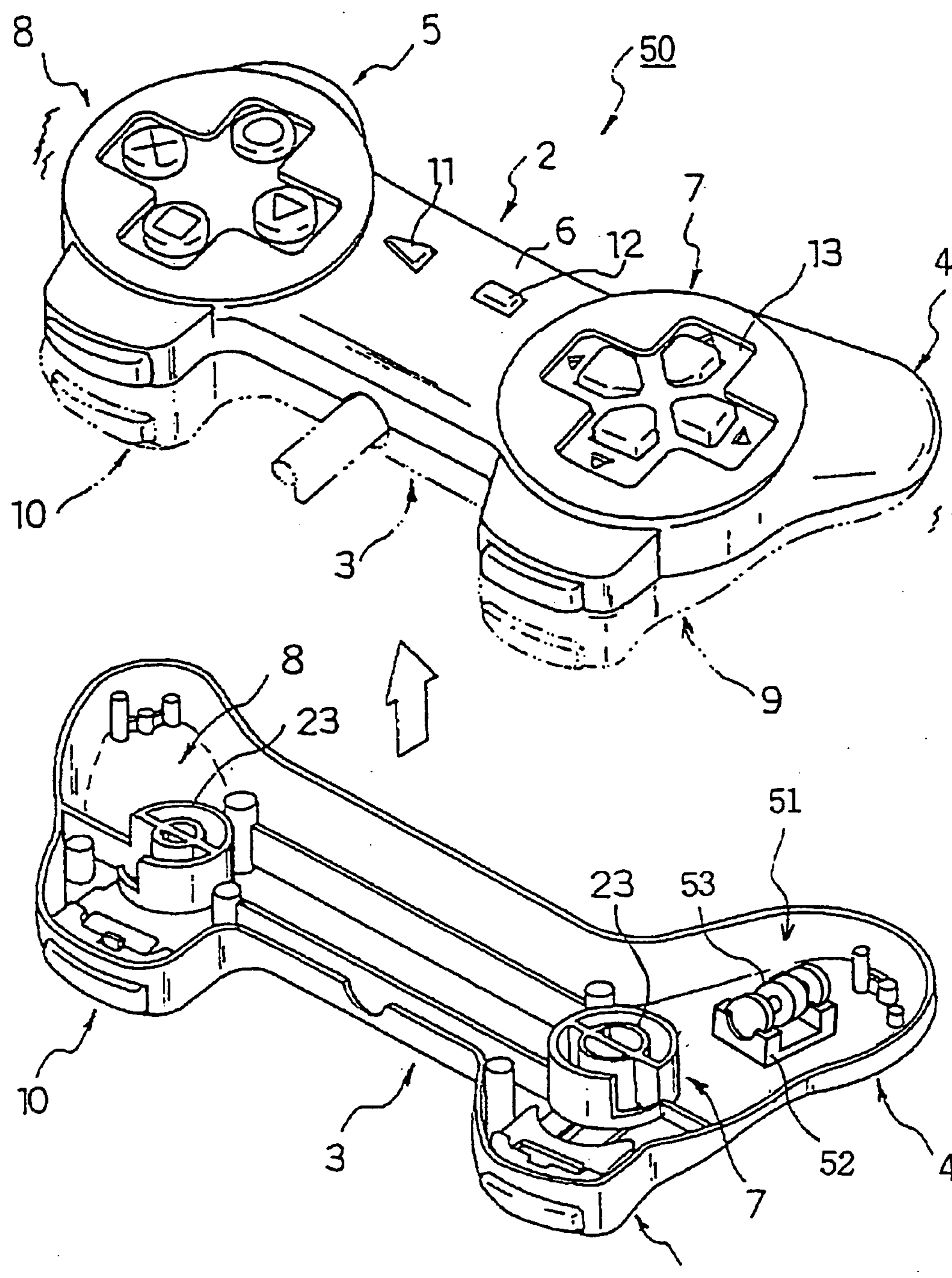


FIG. 16

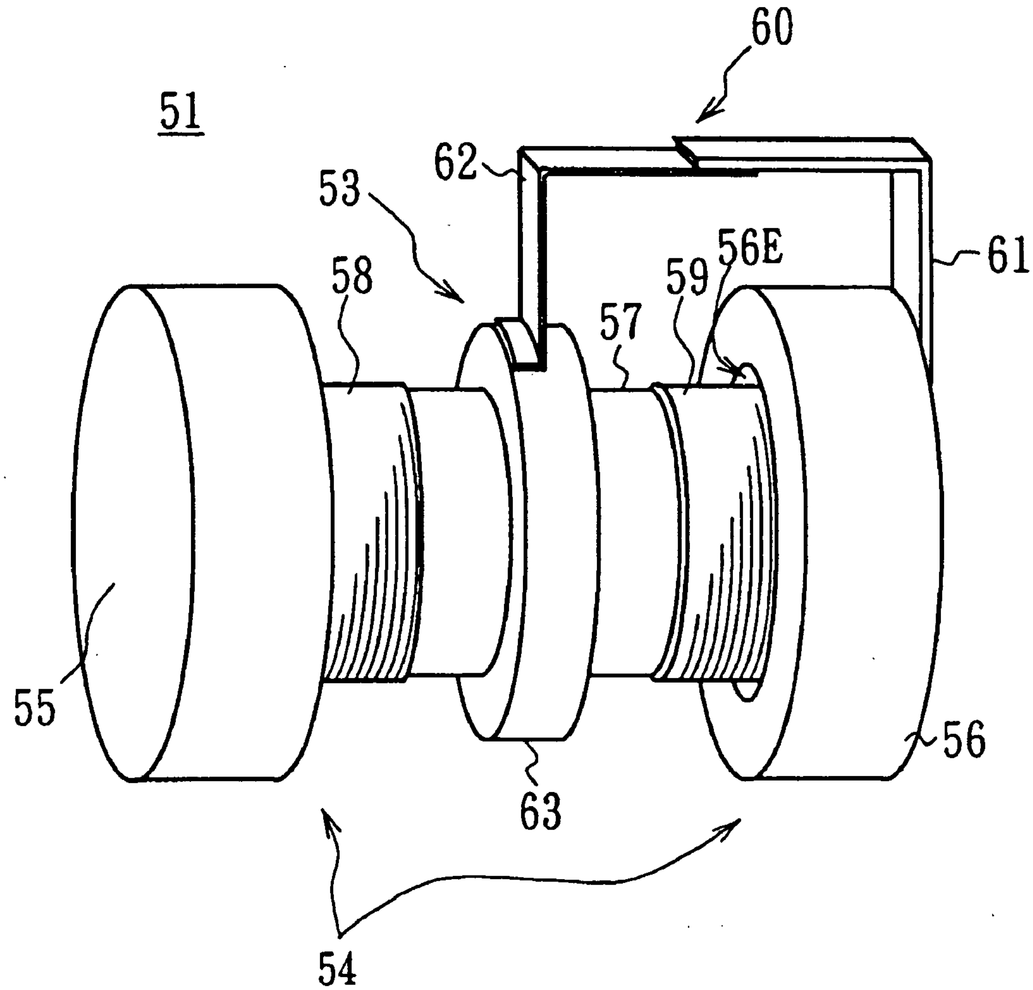


FIG. 17

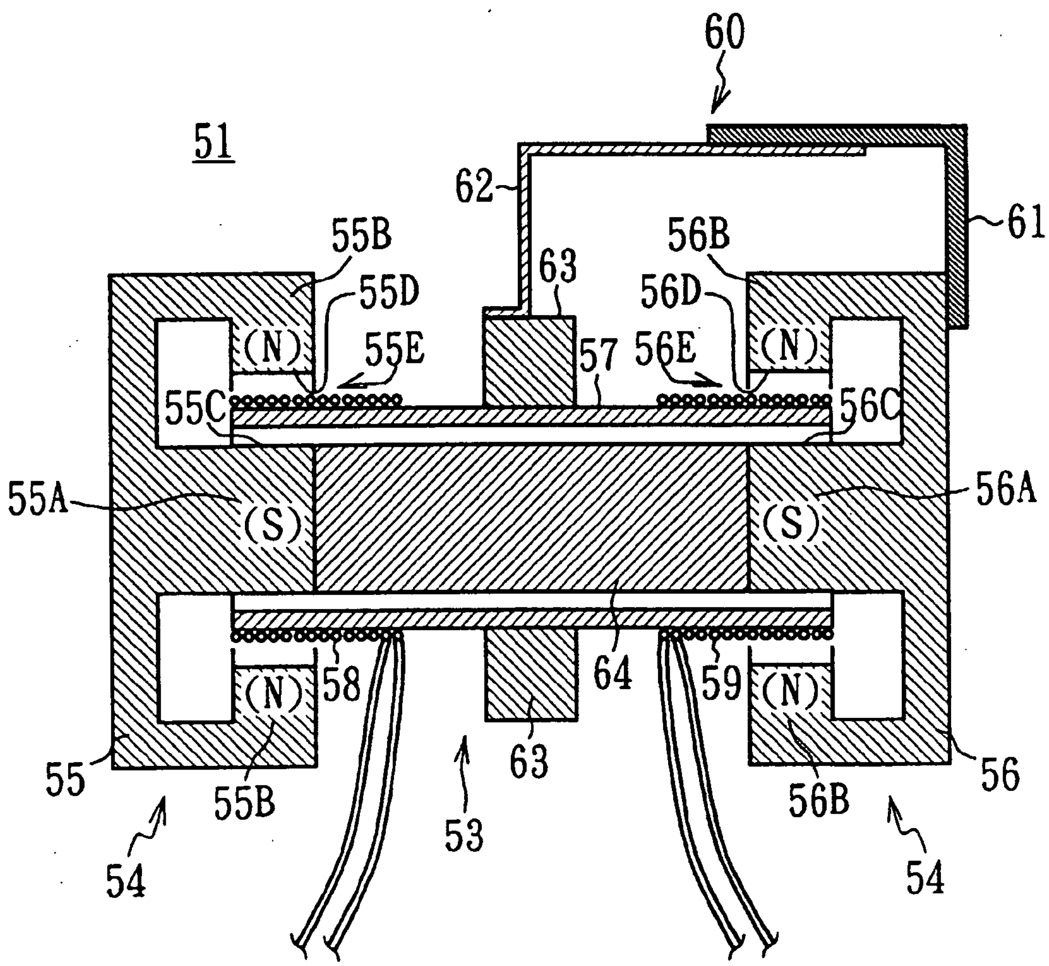

51
60
61
62
63
55B
55D
55E
57
56B
56D
56E
55C
56C
55A
56A
(N)
(S)
58
64
59
55
55B
63
53
56B
56
54

FIG. 18

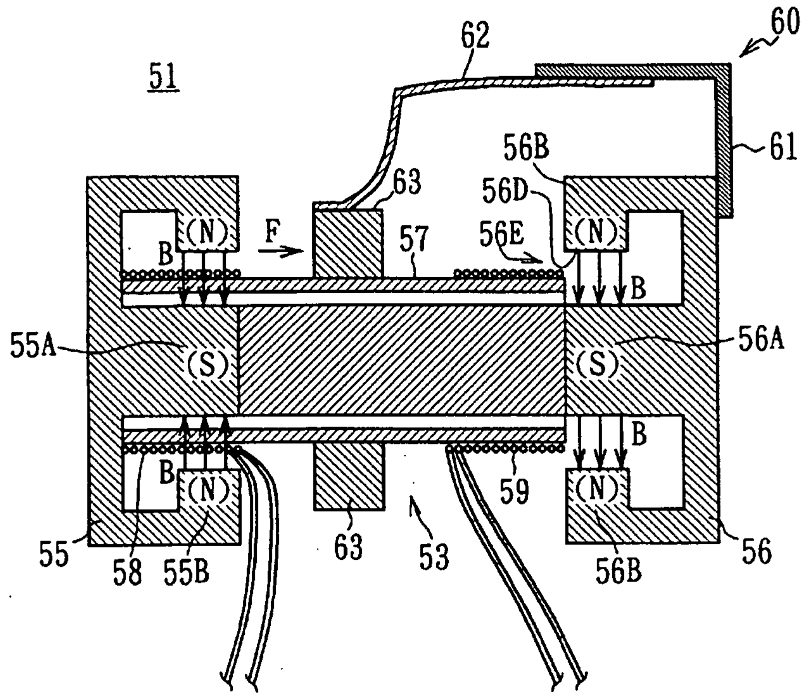


FIG. 19A

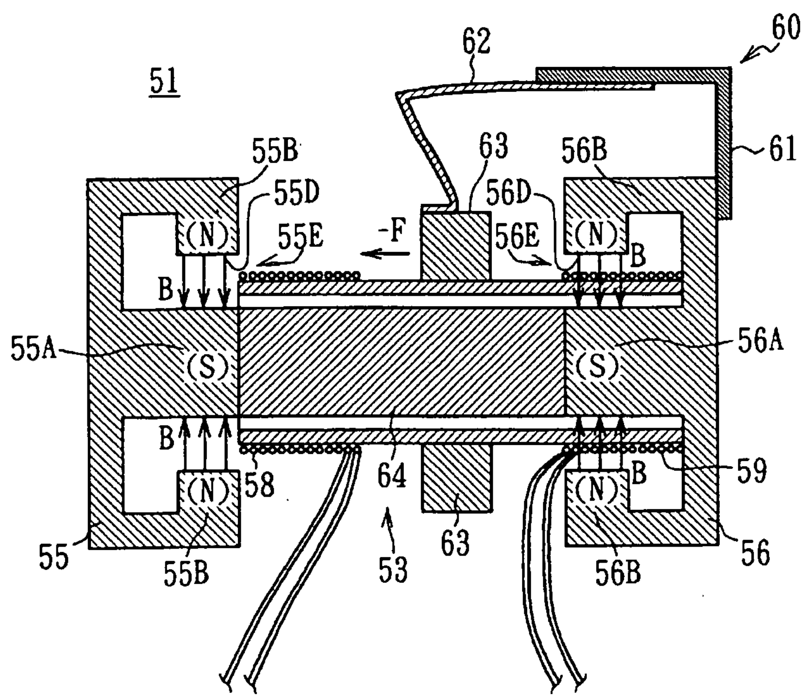


FIG. 19B

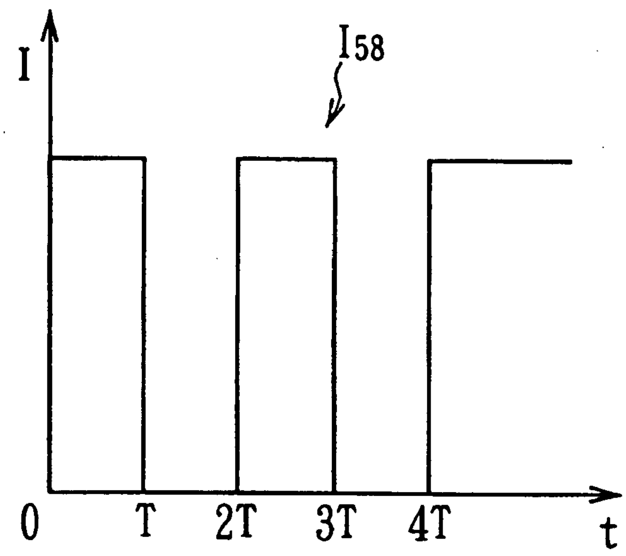


FIG. 20A

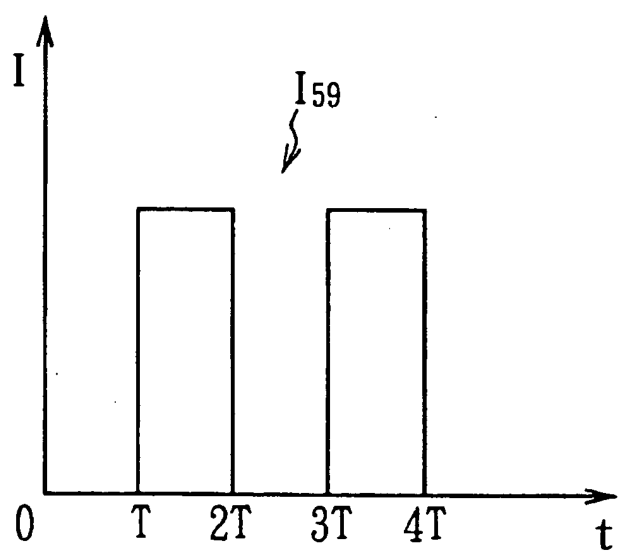


FIG. 20B

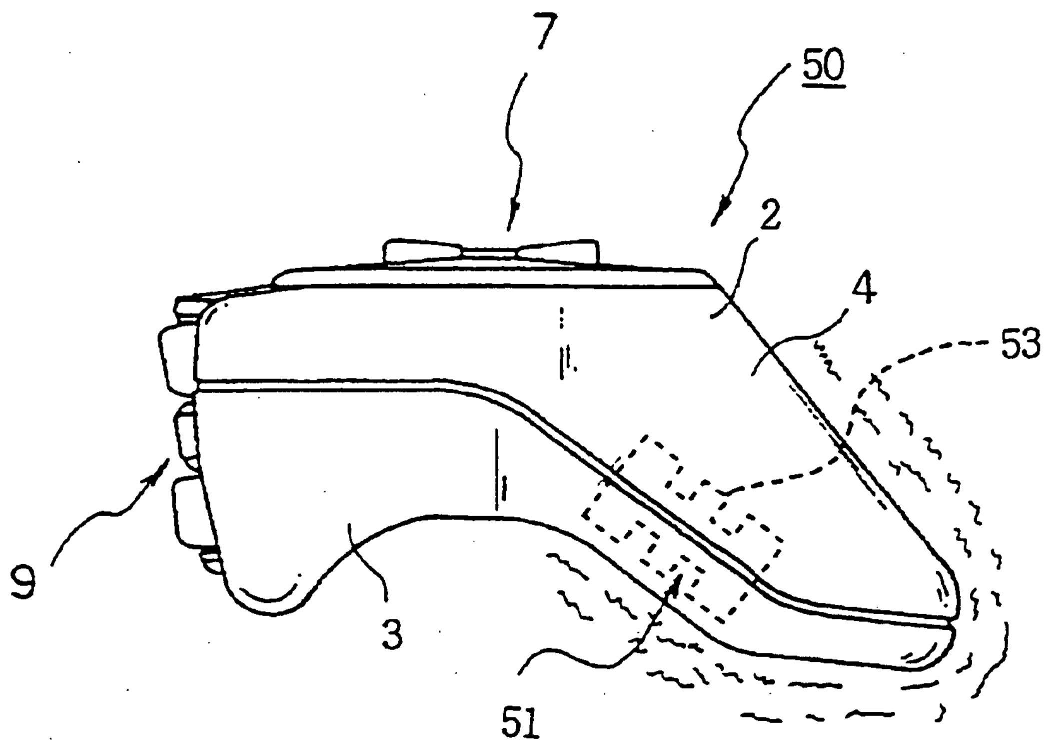


FIG. 21

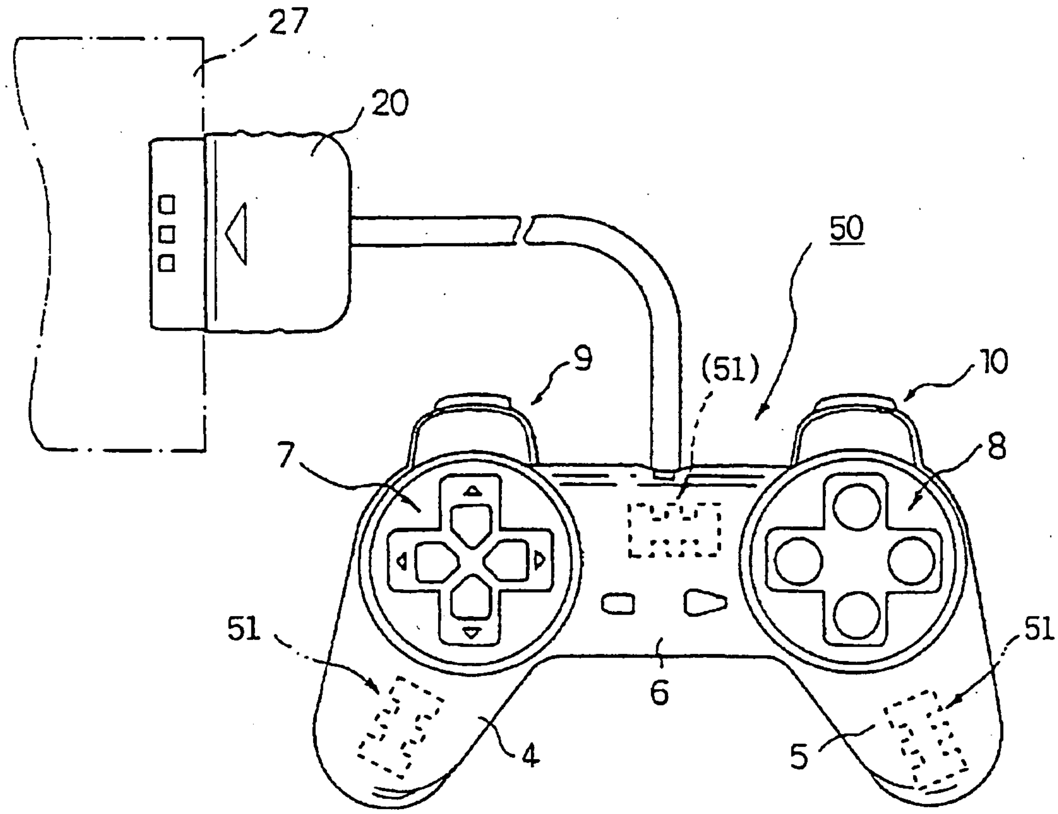


FIG. 22

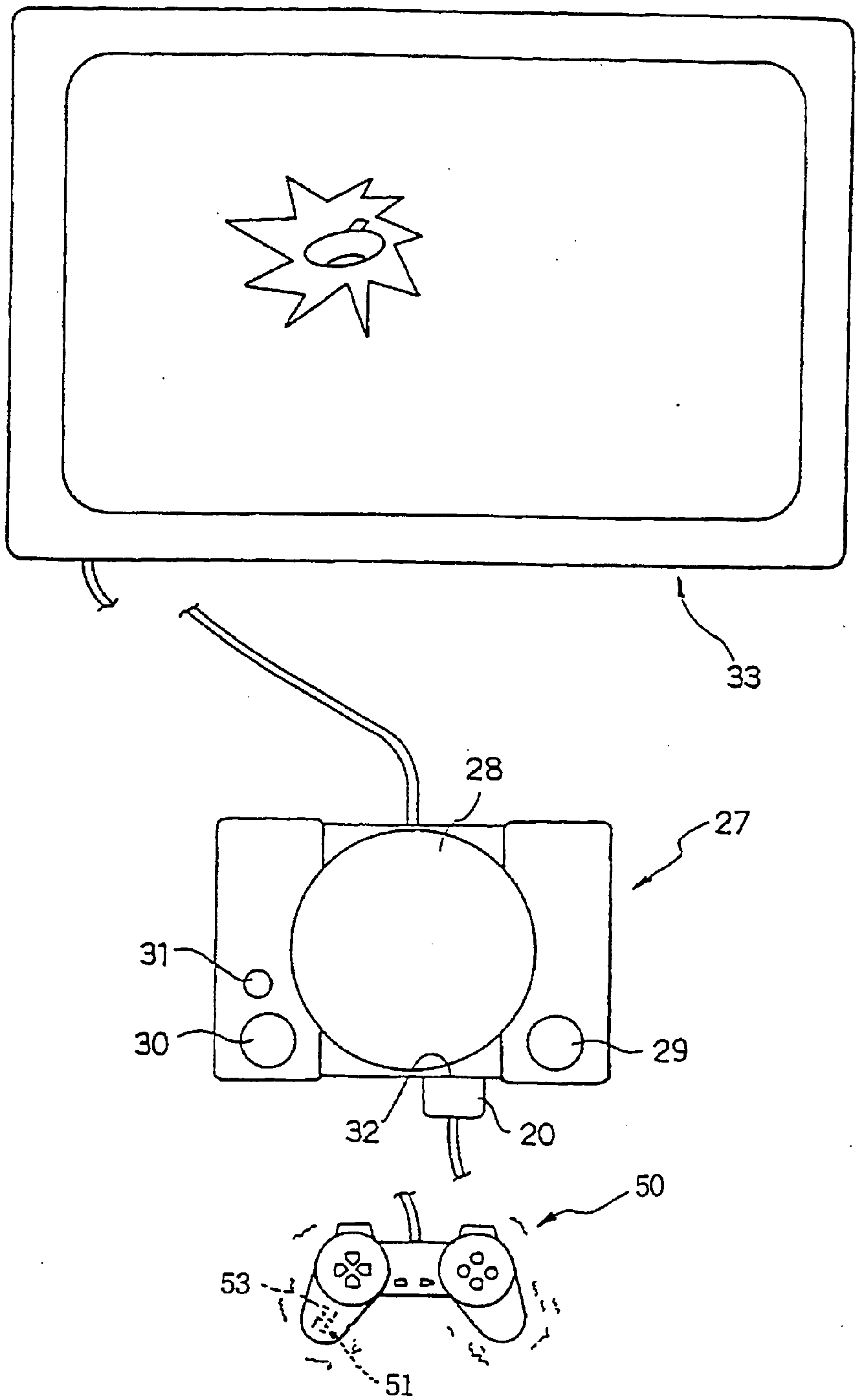


FIG. 23

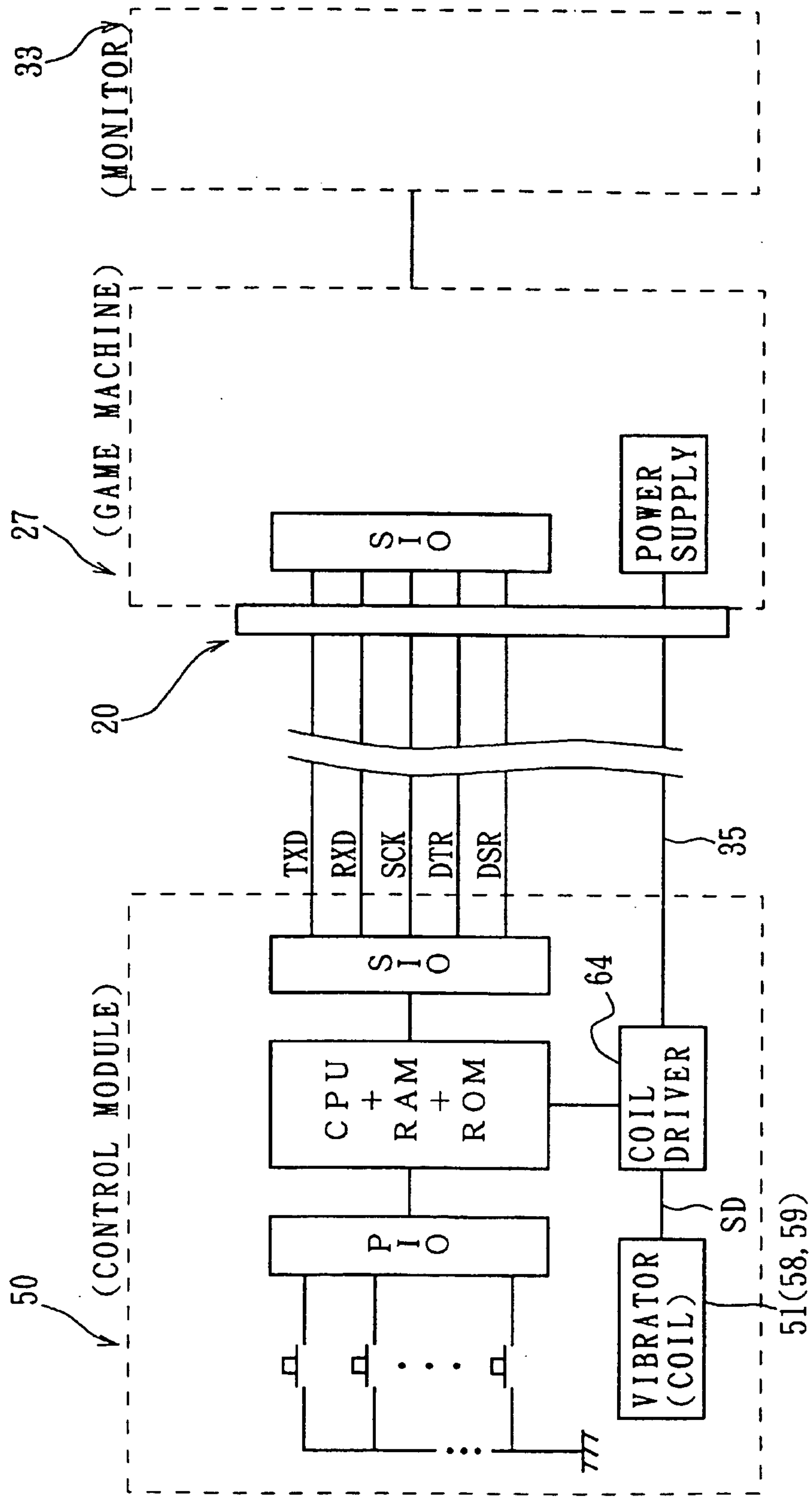

33
(MONITOR)
27
(GAME MACHINE)
SIO
POWER SUPPLY
20
TXD
RXD
SCK
DTR
DSR
35
50
(CONTROL MODULE)
SIO
64
CPU + RAM + ROM
COIL DRIVER
PIO
SD
VIBRATOR (COIL)
51(58, 59)

FIG. 24

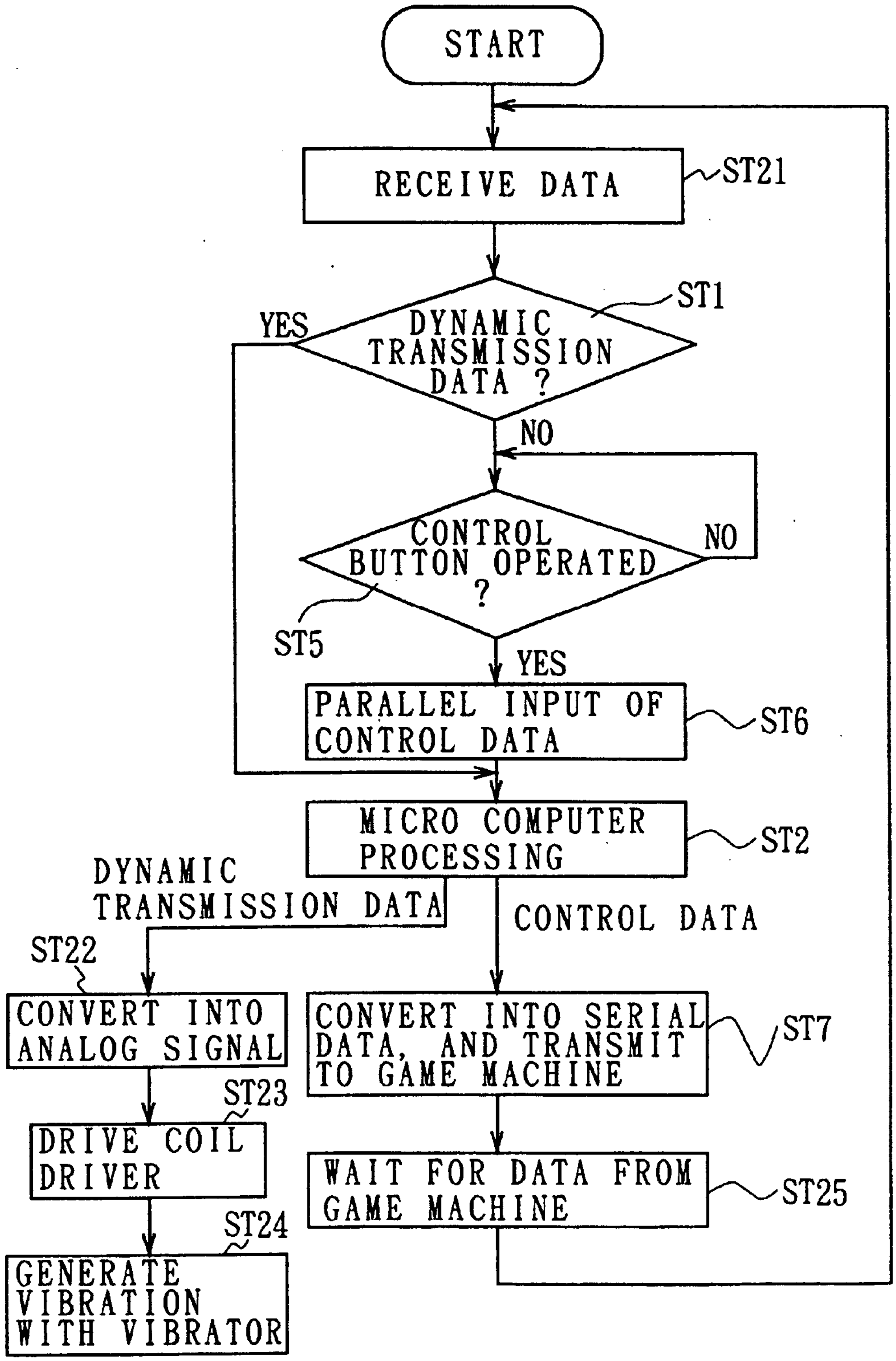

START
RECEIVE DATA
ST21
DYNAMIC TRANSMISSION DATA ?
ST1
YES
NO
CONTROL BUTTON OPERATED ?
NO
ST5
YES
PARALLEL INPUT OF CONTROL DATA
ST6
MICRO COMPUTER PROCESSING
ST2
DYNAMIC TRANSMISSION DATA
CONTROL DATA
ST22
CONVERT INTO ANALOG SIGNAL
CONVERT INTO SERIAL DATA, AND TRANSMIT TO GAME MACHINE
ST7
ST23
DRIVE COIL DRIVER
WAIT FOR DATA FROM GAME MACHINE
ST25
ST24
GENERATE VIBRATION WITH VIBRATOR

FIG. 25

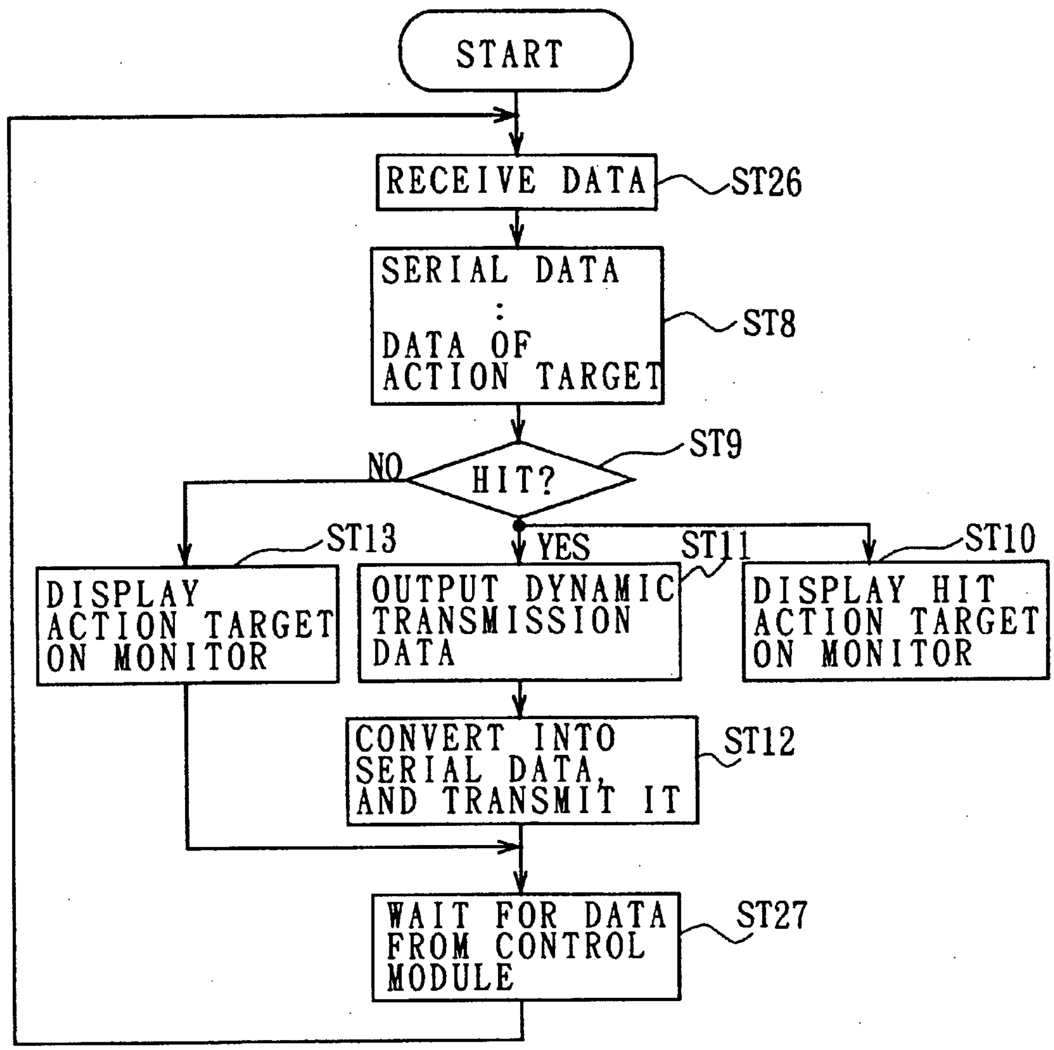

START
RECEIVE DATA
ST26
SERIAL DATA
:
DATA OF
ACTION TARGET
ST8
HIT?
ST9
NO
YES
ST13
DISPLAY
ACTION TARGET
ON MONITOR
ST11
OUTPUT DYNAMIC
TRANSMISSION
DATA
ST10
DISPLAY HIT
ACTION TARGET
ON MONITOR
CONVERT INTO
SERIAL DATA,
AND TRANSMIT IT
ST12
WAIT FOR DATA
FROM CONTROL
MODULE
ST27

FIG. 26

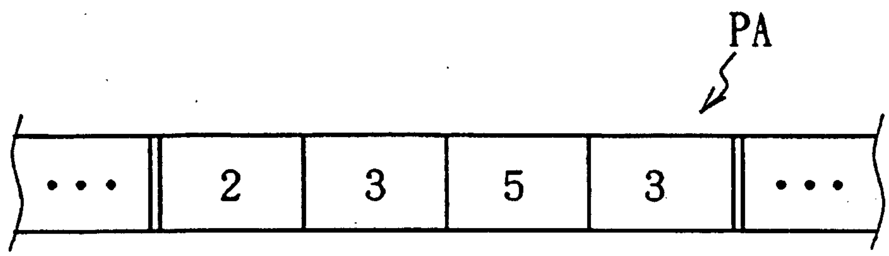


FIG. 27A

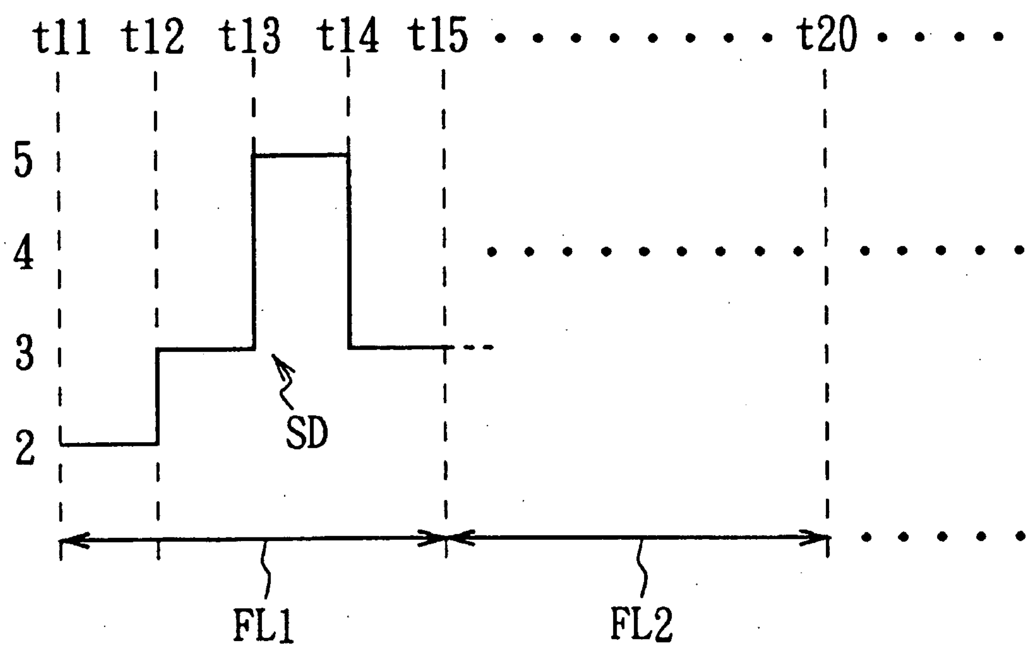


FIG. 27B

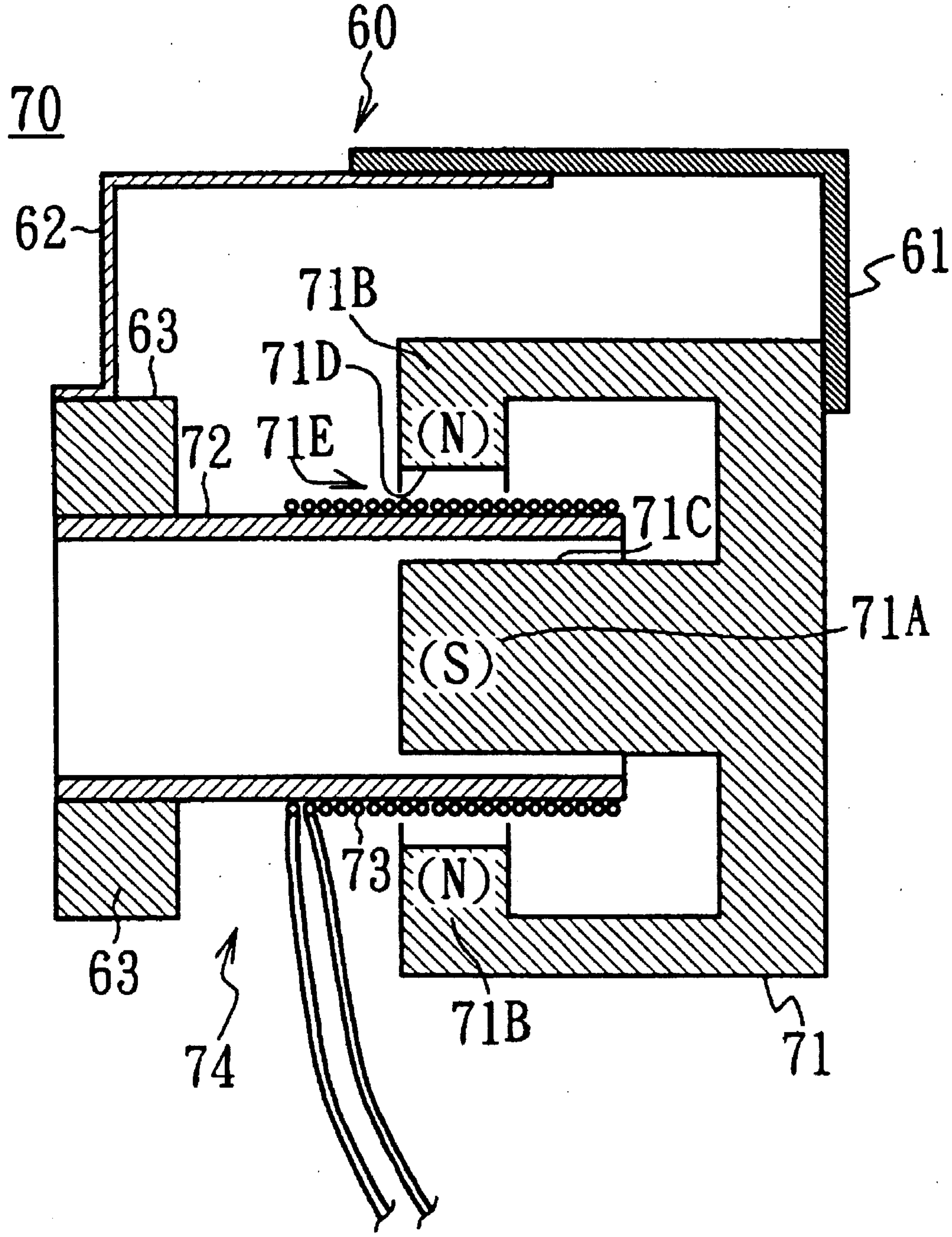


FIG. 28

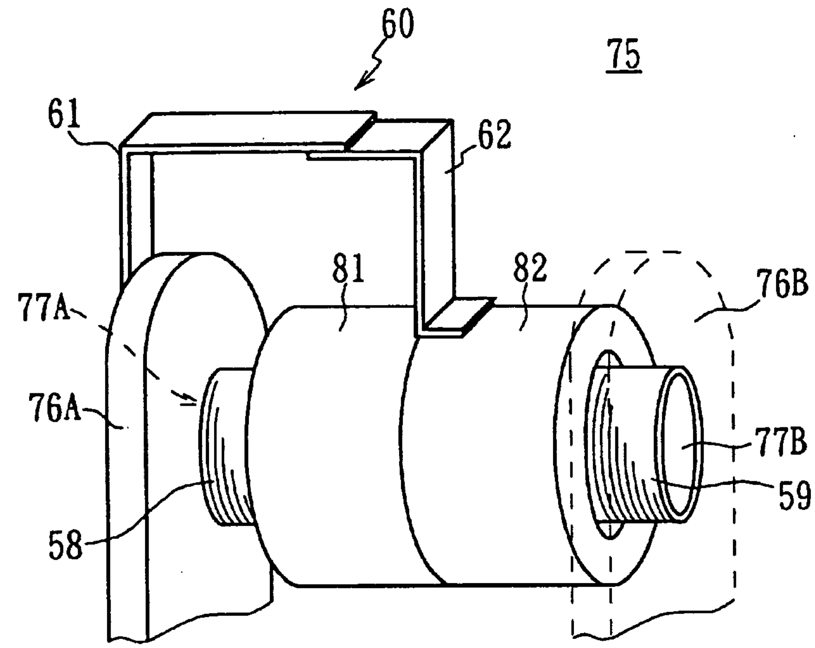

60
75
61
62
81
82
76B
77A
76A
77B
59
58

FIG. 29

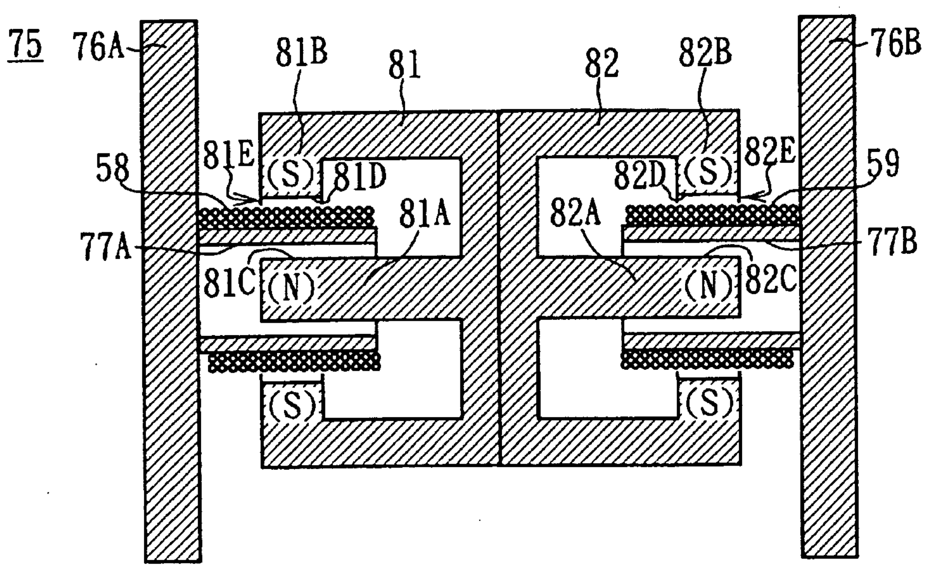

75
76A
81B
81
82
82B
76B
58
81E
(S)
81D
82D
(S)
82E
59
81A
82A
77A
77B
81C
(N)
(N)
82C
(S)
(S)

FIG. 30

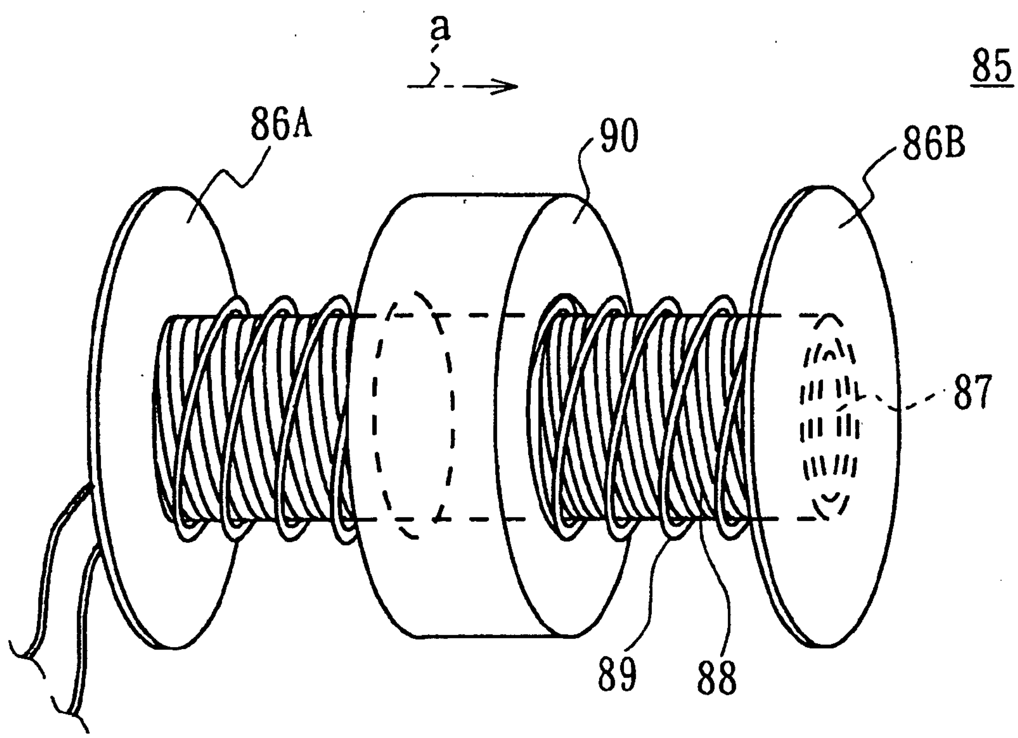


FIG. 31

FIG. 32A

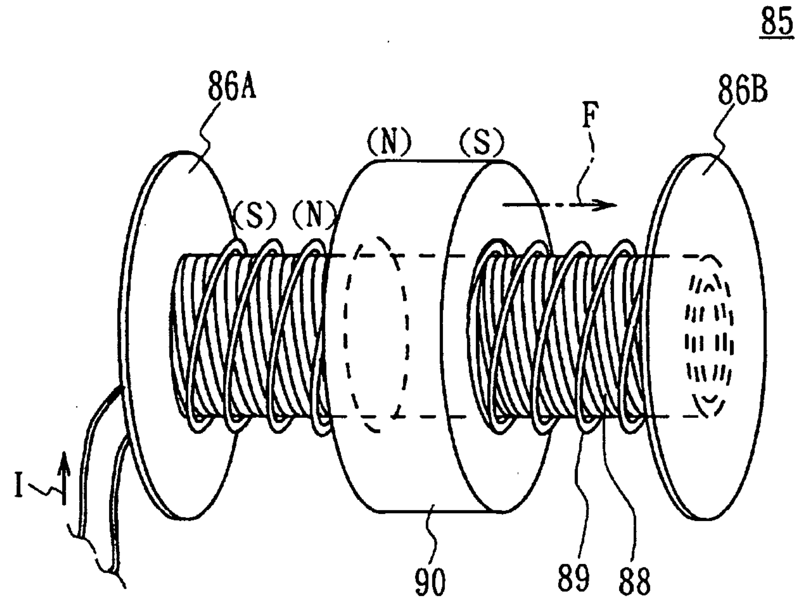
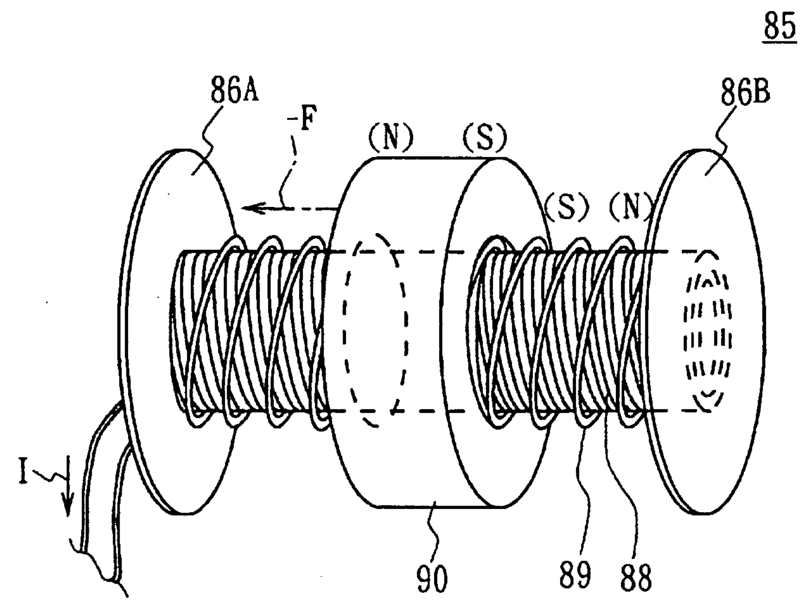


FIG. 32B



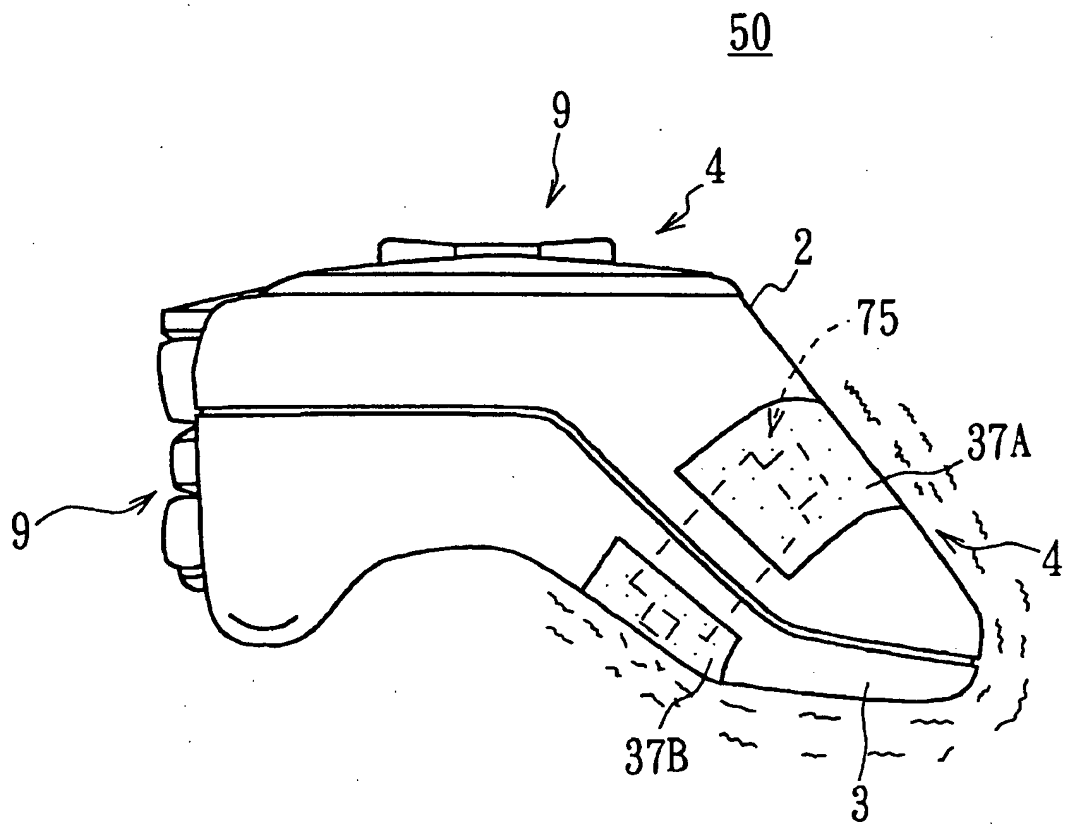


FIG. 33

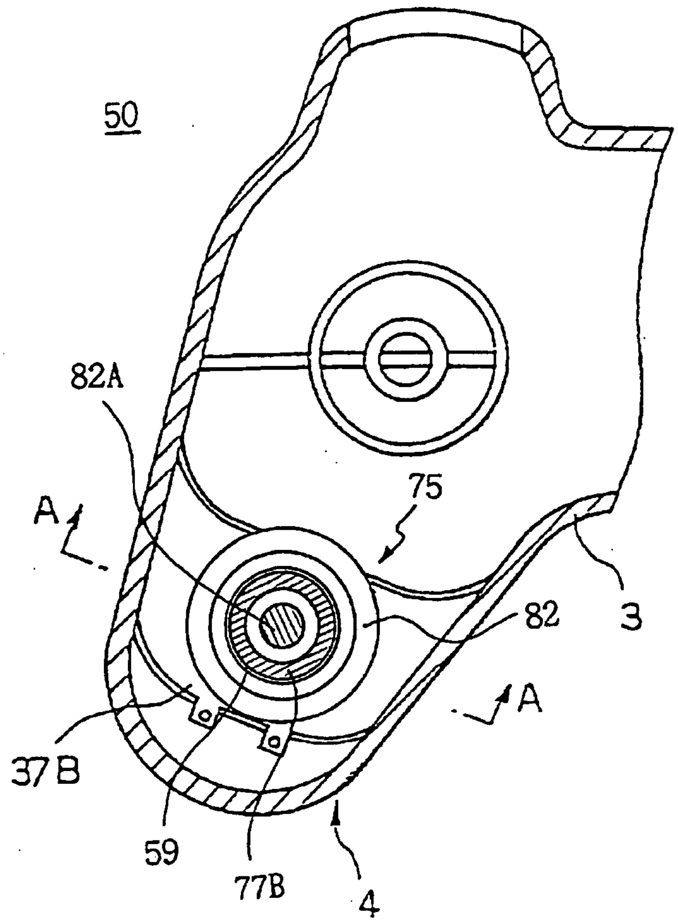

50
82A
A
75
82
3
A
37B
59
77B
4

FIG. 34

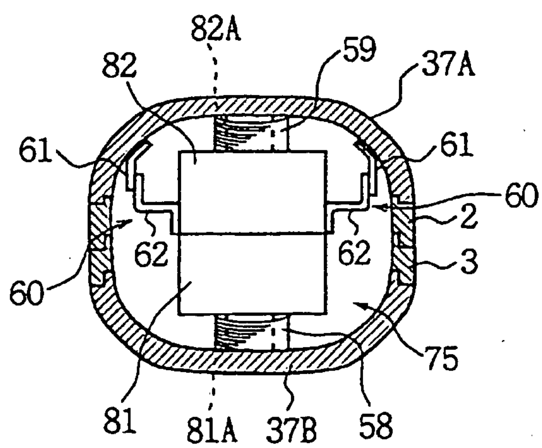

82A
82
59
37A
61
61
60
2
62
62
3
60
75
81
81A
37B
58

FIG. 35

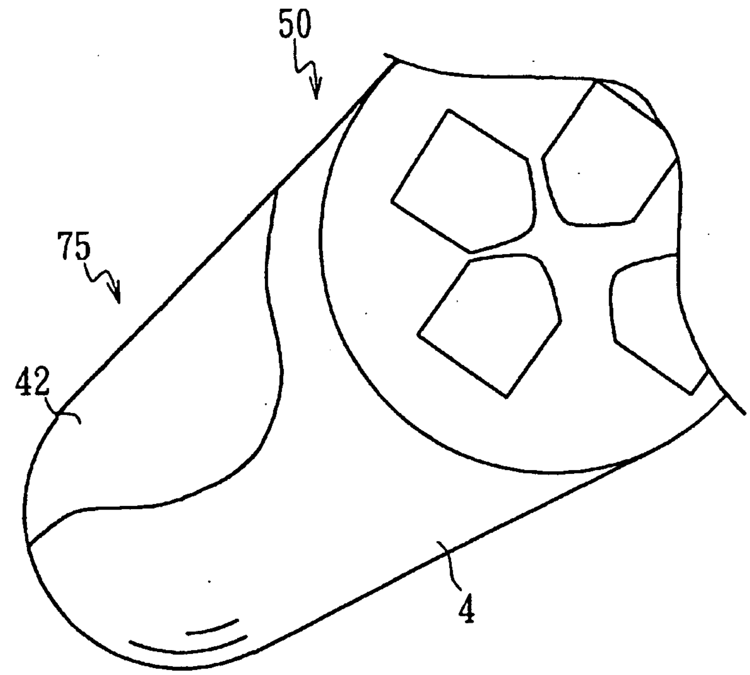


FIG. 36

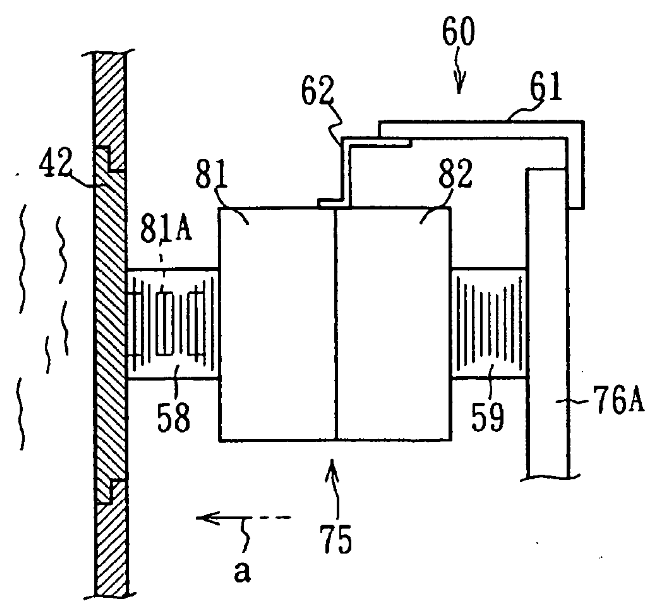


FIG. 37

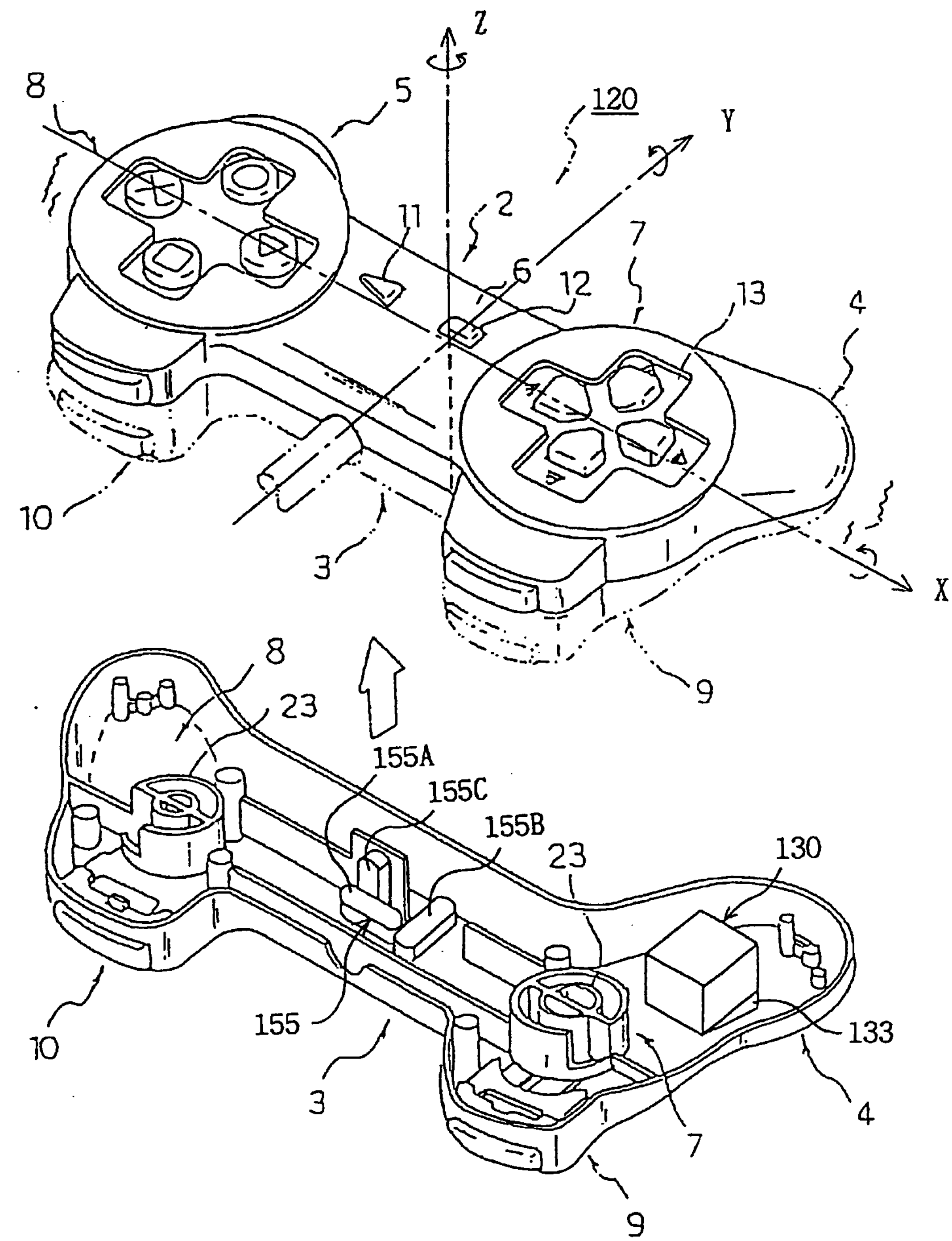

Z
8
5
120
Y
11
2
7
6
12
13
4
10
3
X
9
8
23
155A
155C
155B
23
130
10
155
3
7
133
4
9

FIG. 38

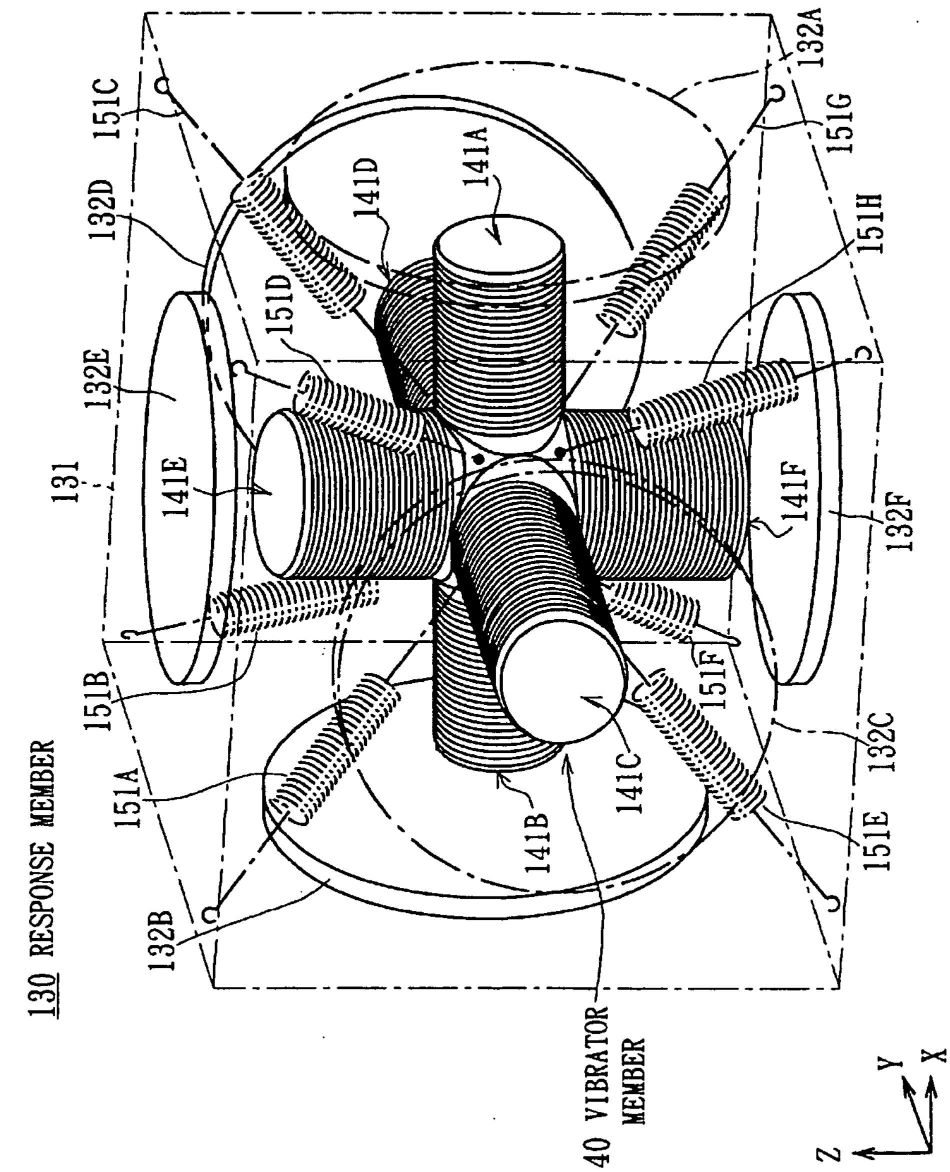

130 RESPONSE MEMBER
131
132A
132B
132C
132D
132E
132F
141A
141B
141C
141D
141E
141F
151A
151B
151C
151D
151E
151F
151G
151H
140 VIBRATOR MEMBER
Z
Y
X

FIG. 39

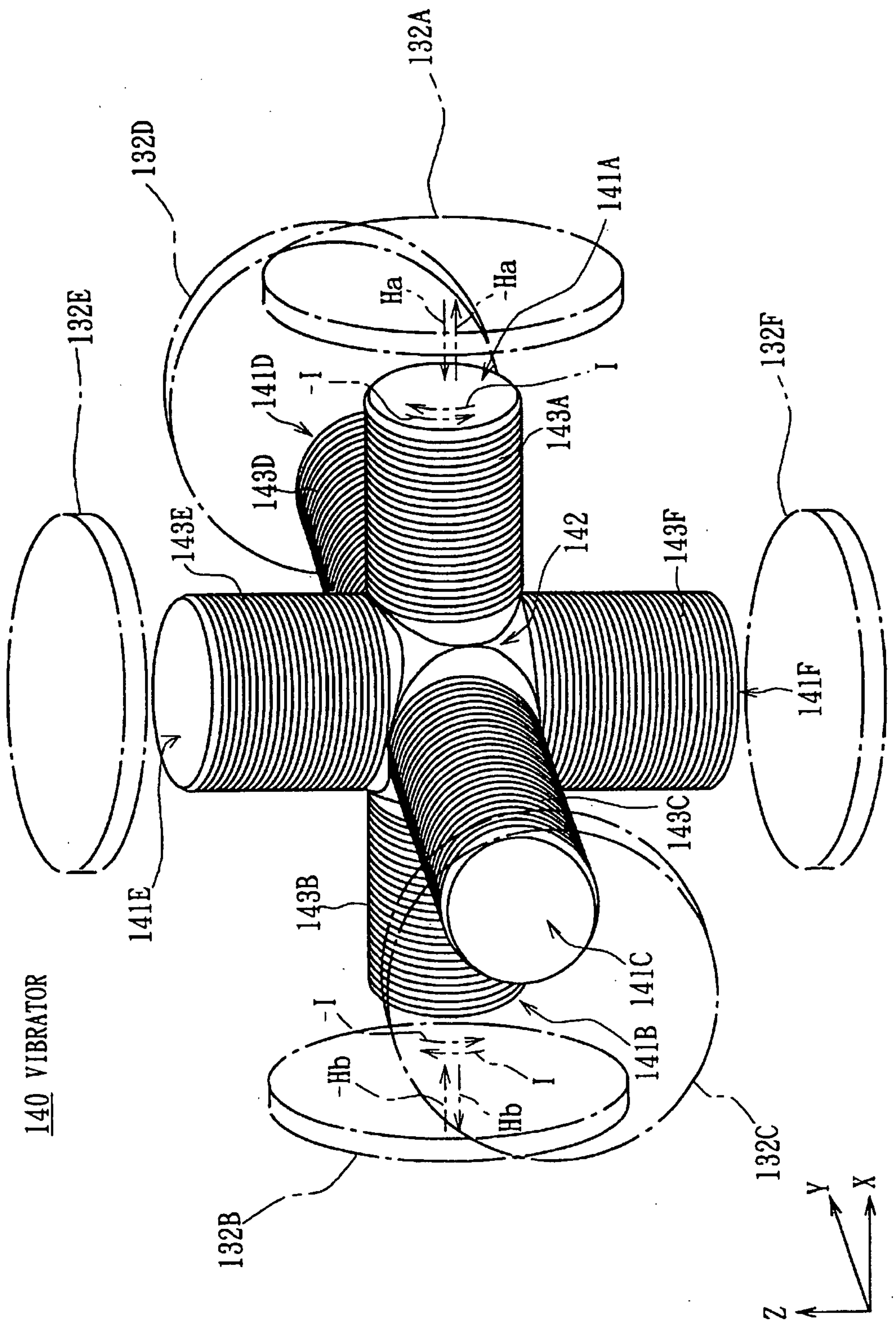

140 VIBRATOR
132A
132B
132C
132D
132E
132F
141A
141B
141C
141D
141E
141F
142
143A
143B
143C
143D
143E
143F
Ha
-Ha
Hb
-Hb
I
-I
X
Y
Z

FIG. 40

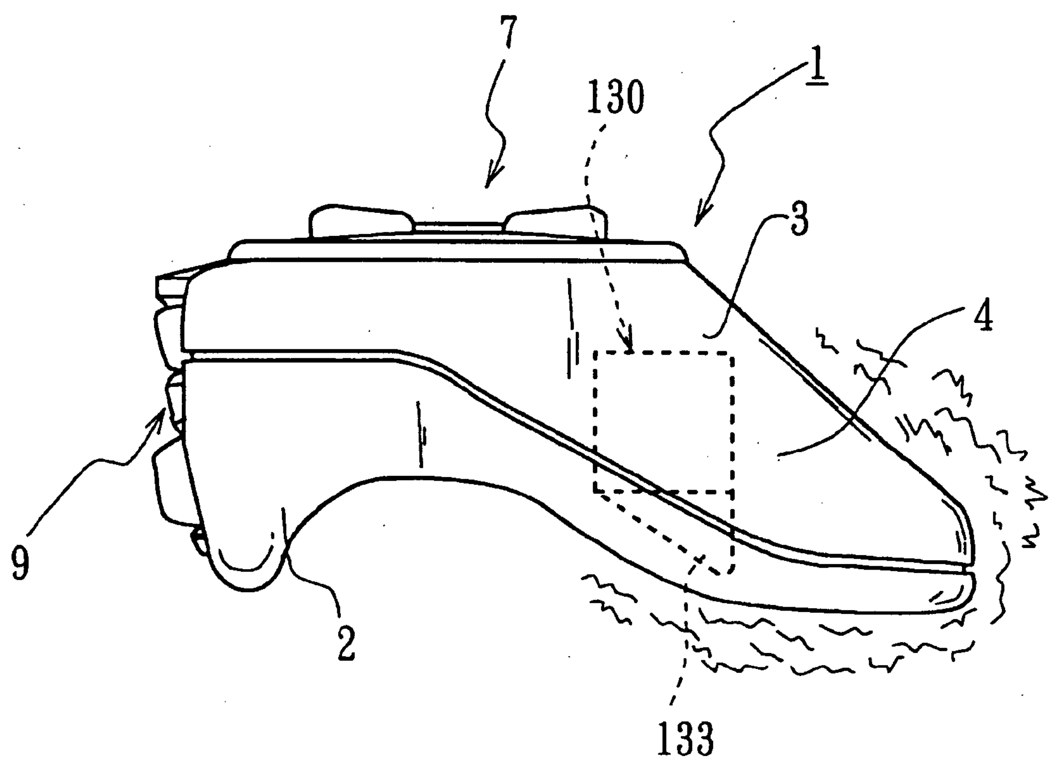


FIG. 41

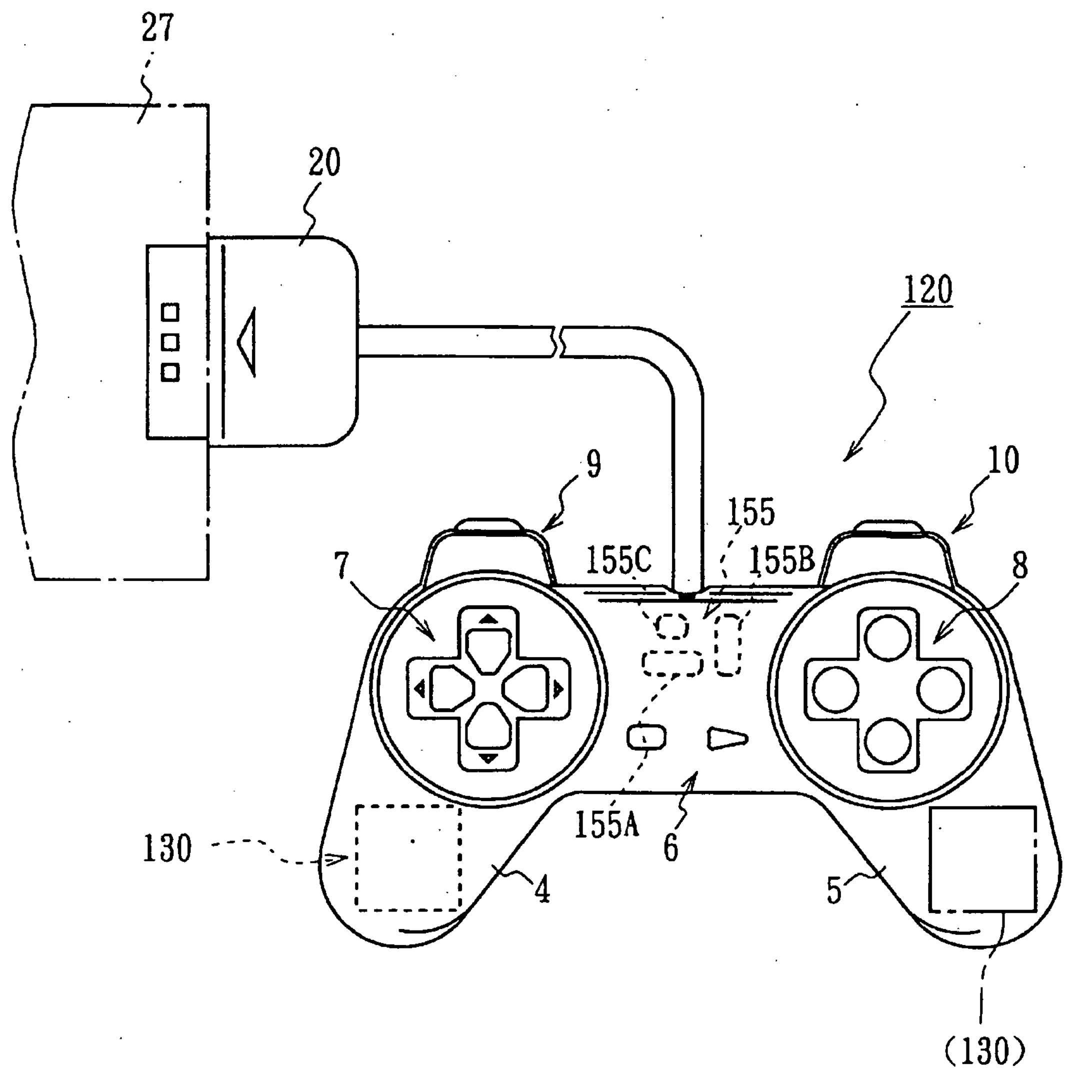


FIG. 42

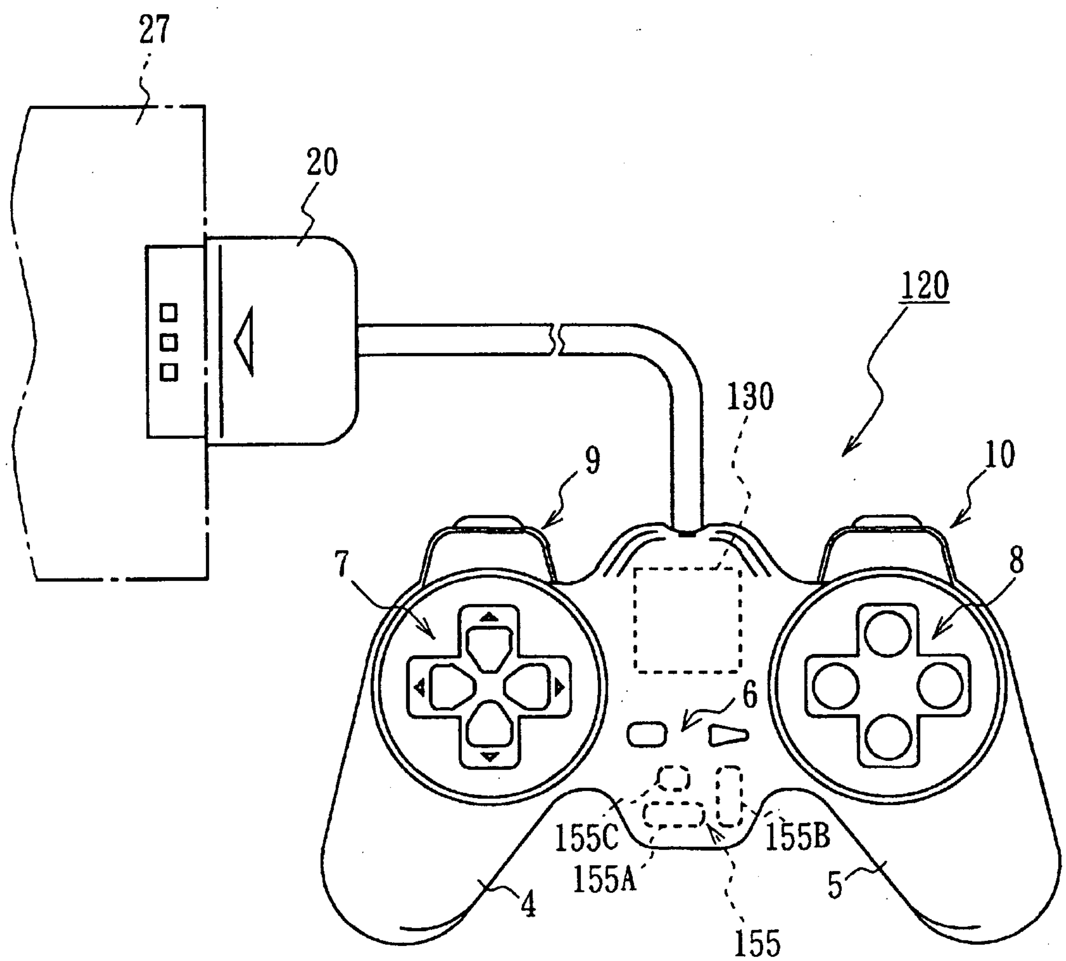


FIG. 43

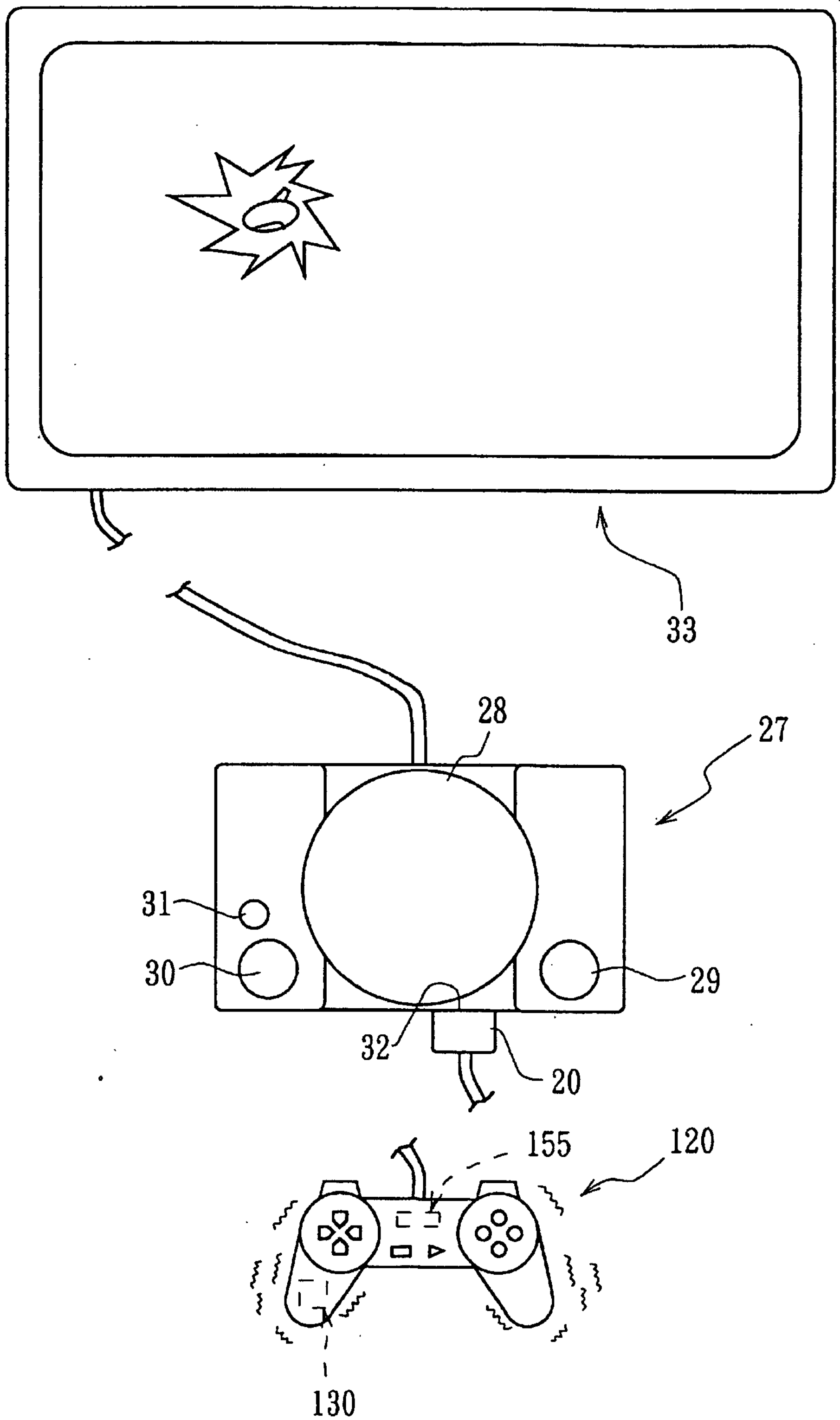
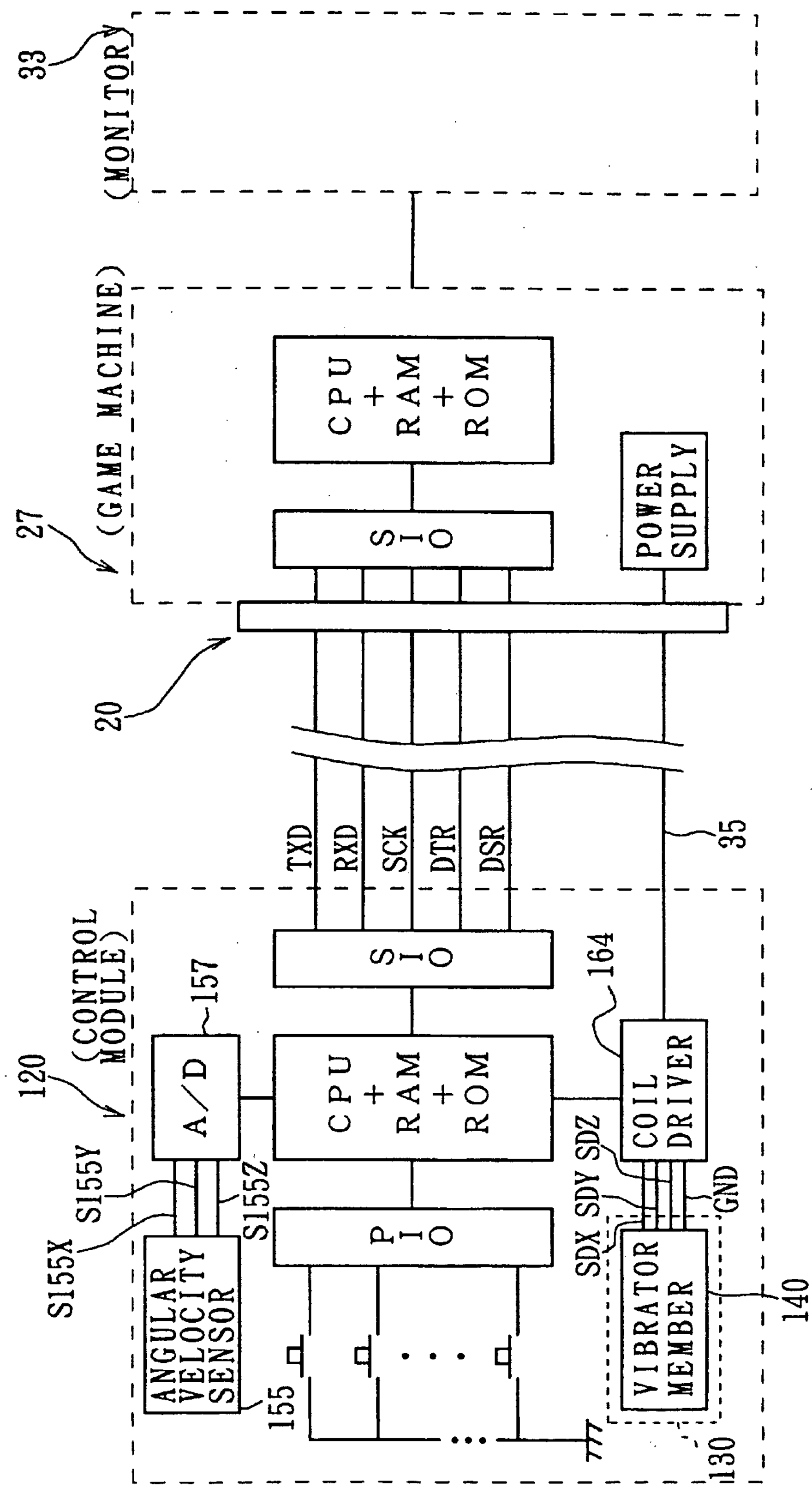


FIG. 44



33
(MONITOR)
27
(GAME MACHINE)
CPU + RAM + ROM
SIO
POWER SUPPLY
20
TXD
RXD
SCK
DTR
DSR
35
120
(CONTROL MODULE)
157
A/D
CPU + RAM + ROM
SIO
164
COIL DRIVER
PIO
S155X
S155Y
S155Z
ANGULAR VELOCITY SENSOR
155
SDX SDY SDZ
GND
VIBRATOR MEMBER
140
130

FIG. 45

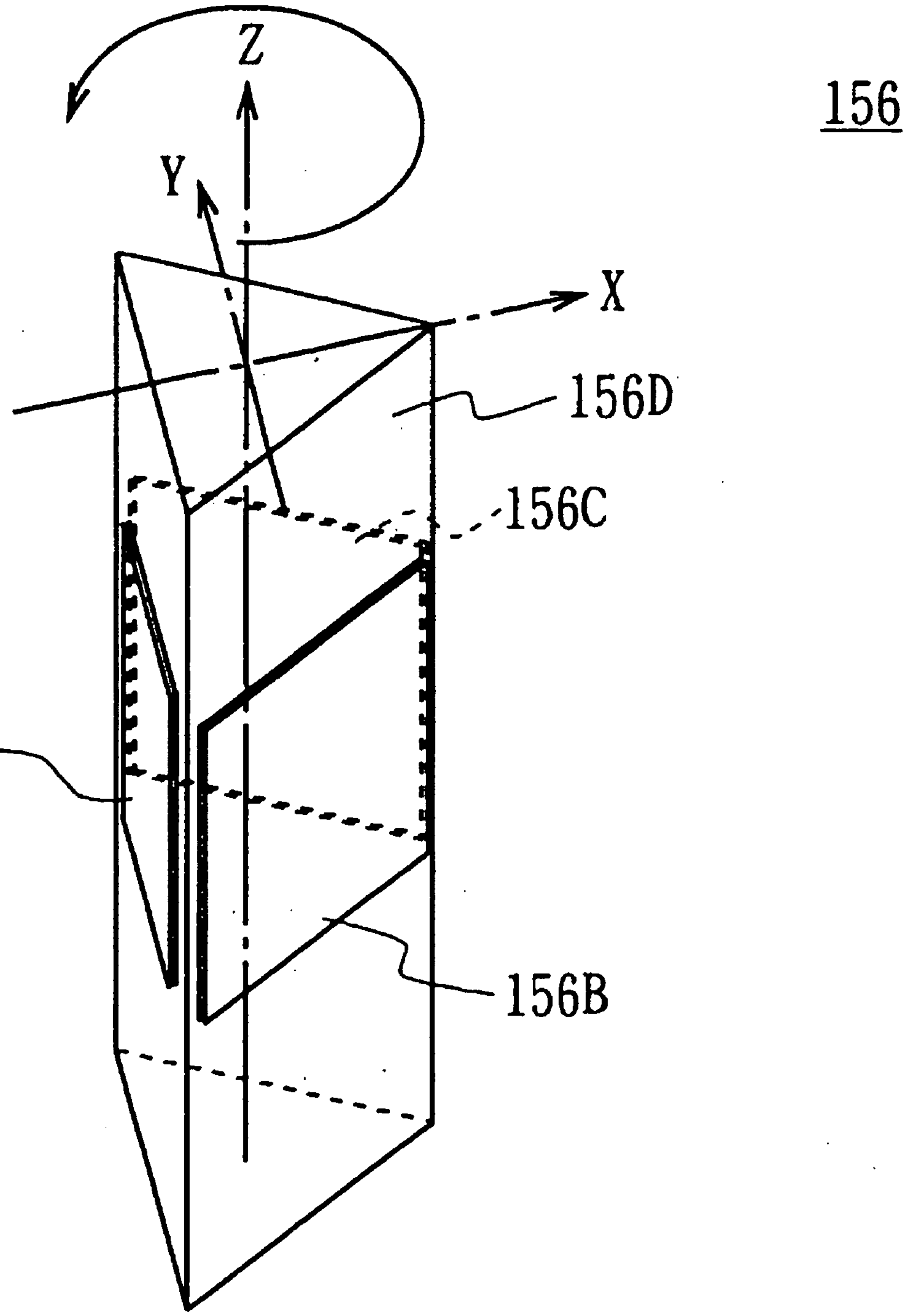


FIG. 46

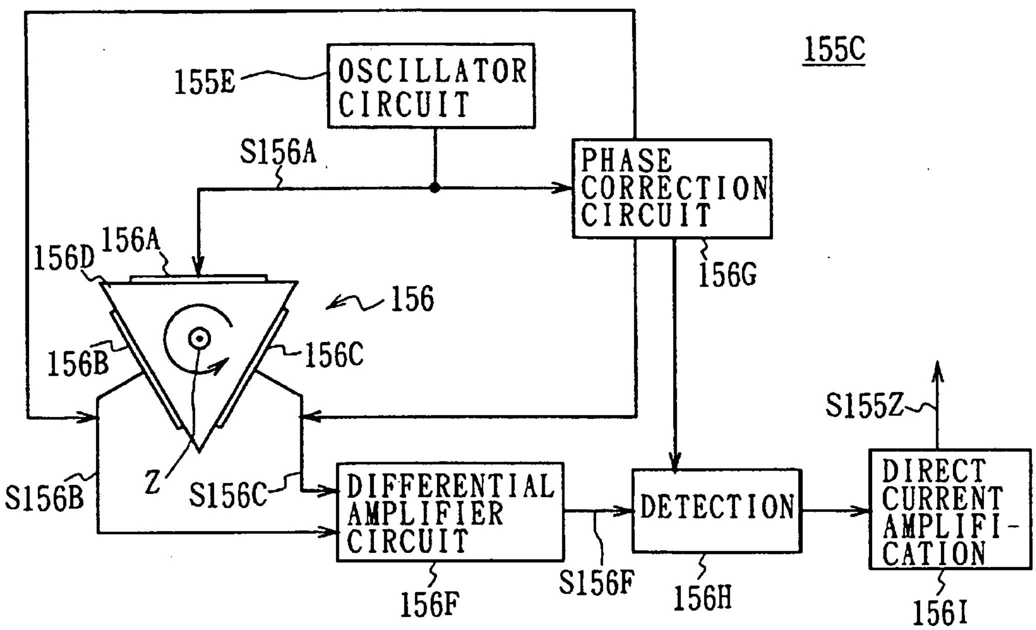


FIG. 47

	1ST BYTE	2ND BYTE	3RD BYTE	4TH BYTE	5TH BYTE
RECEIVED DATA FROM GAME MACHINE	0x01	0x42	—	DATA (TXD1)	DATA (TXD2)
TRANSMISSION DATA TO GAME MACHINE	—	0x42	0x5a	DATA (RXD1)	DATA (RXD2)

FIG. 48

1ST BYTE	PROTOCOL IDENTIFIER (0x01)							
2ND BYTE	PROTOCOL IDENTIFIER (0x42)							
3RD BYTE	UNDETERMINED							
4TH BYTE (TXD1)	0	1	(DCOM)			(DX)		
5TH BYTE (TXD2)	(DY)			(DZ)				

FIG. 49

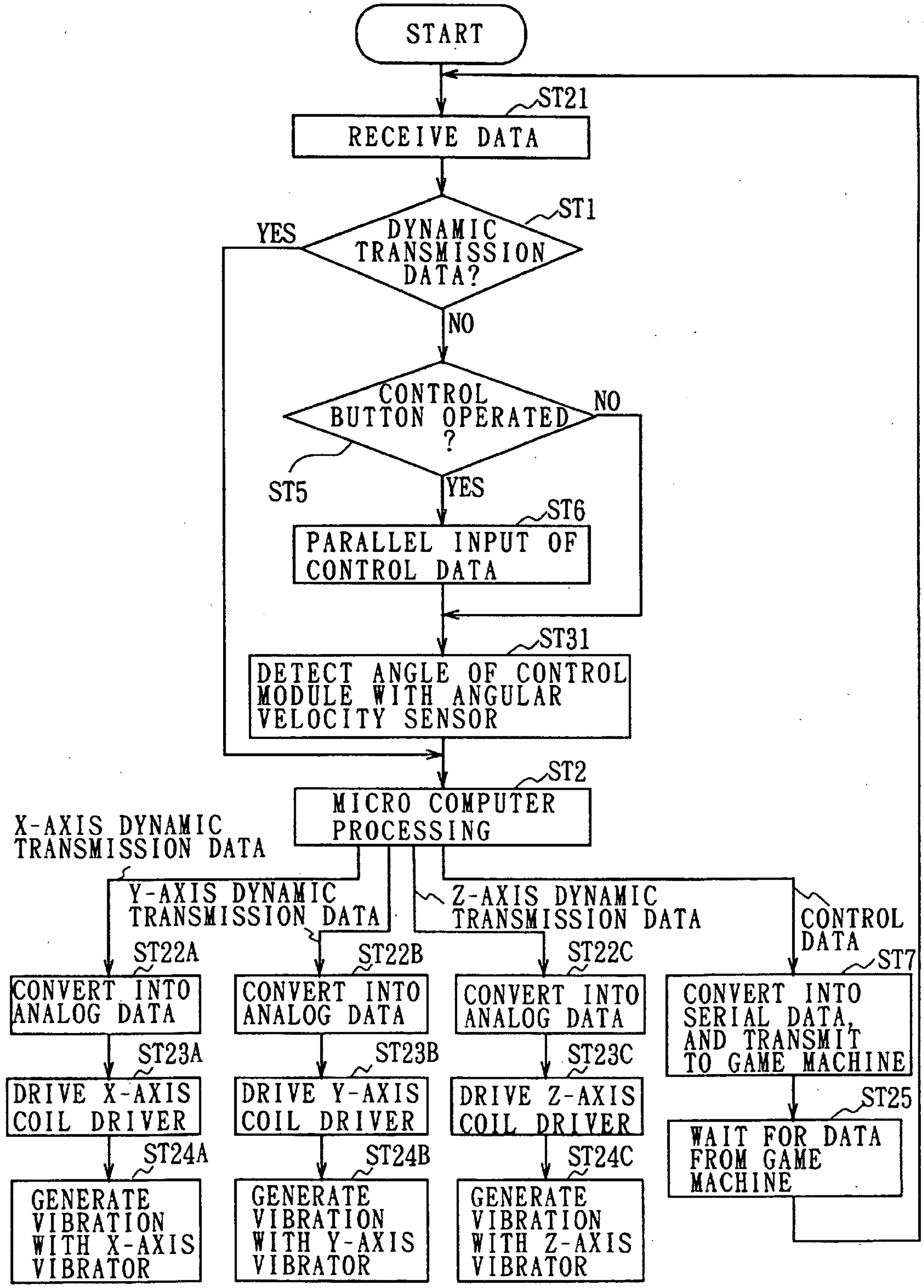

START
ST21
RECEIVE DATA
ST1
YES
DYNAMIC TRANSMISSION DATA?
NO
CONTROL BUTTON OPERATED ?
NO
ST5
YES
ST6
PARALLEL INPUT OF CONTROL DATA
ST31
DETECT ANGLE OF CONTROL MODULE WITH ANGULAR VELOCITY SENSOR
ST2
MICRO COMPUTER PROCESSING
X-AXIS DYNAMIC TRANSMISSION DATA
Y-AXIS DYNAMIC TRANSMISSION DATA
Z-AXIS DYNAMIC TRANSMISSION DATA
CONTROL DATA
ST22A
CONVERT INTO ANALOG DATA
ST23A
DRIVE X-AXIS COIL DRIVER
ST24A
GENERATE VIBRATION WITH X-AXIS VIBRATOR
ST22B
CONVERT INTO ANALOG DATA
ST23B
DRIVE Y-AXIS COIL DRIVER
ST24B
GENERATE VIBRATION WITH Y-AXIS VIBRATOR
ST22C
CONVERT INTO ANALOG DATA
ST23C
DRIVE Z-AXIS COIL DRIVER
ST24C
GENERATE VIBRATION WITH Z-AXIS VIBRATOR
ST7
CONVERT INTO SERIAL DATA, AND TRANSMIT TO GAME MACHINE
ST25
WAIT FOR DATA FROM GAME MACHINE

FIG. 50

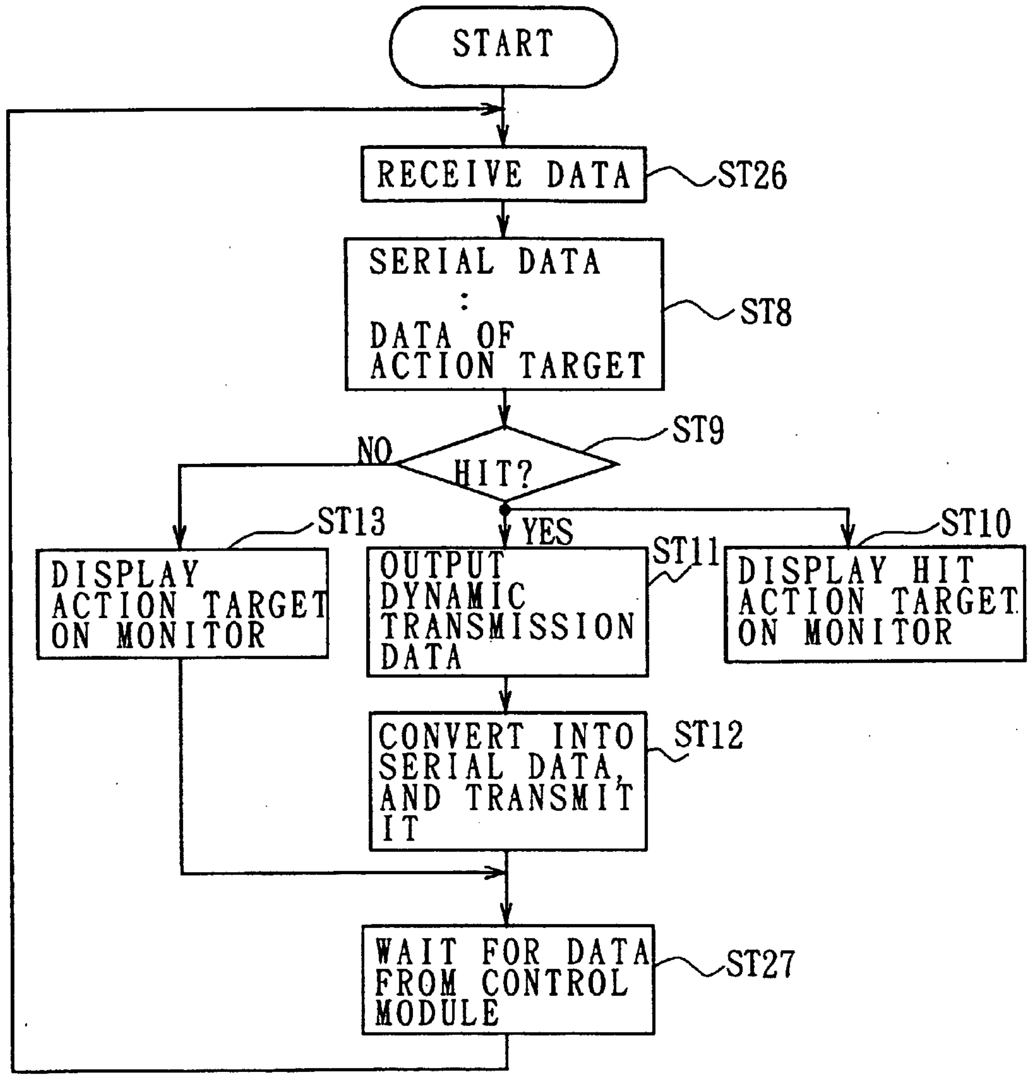

START
RECEIVE DATA
ST26
SERIAL DATA
:
DATA OF ACTION TARGET
ST8
HIT?
ST9
NO
YES
DISPLAY ACTION TARGET ON MONITOR
ST13
OUTPUT DYNAMIC TRANSMISSION DATA
ST11
DISPLAY HIT ACTION TARGET ON MONITOR
ST10
CONVERT INTO SERIAL DATA, AND TRANSMIT IT
ST12
WAIT FOR DATA FROM CONTROL MODULE
ST27

FIG. 51

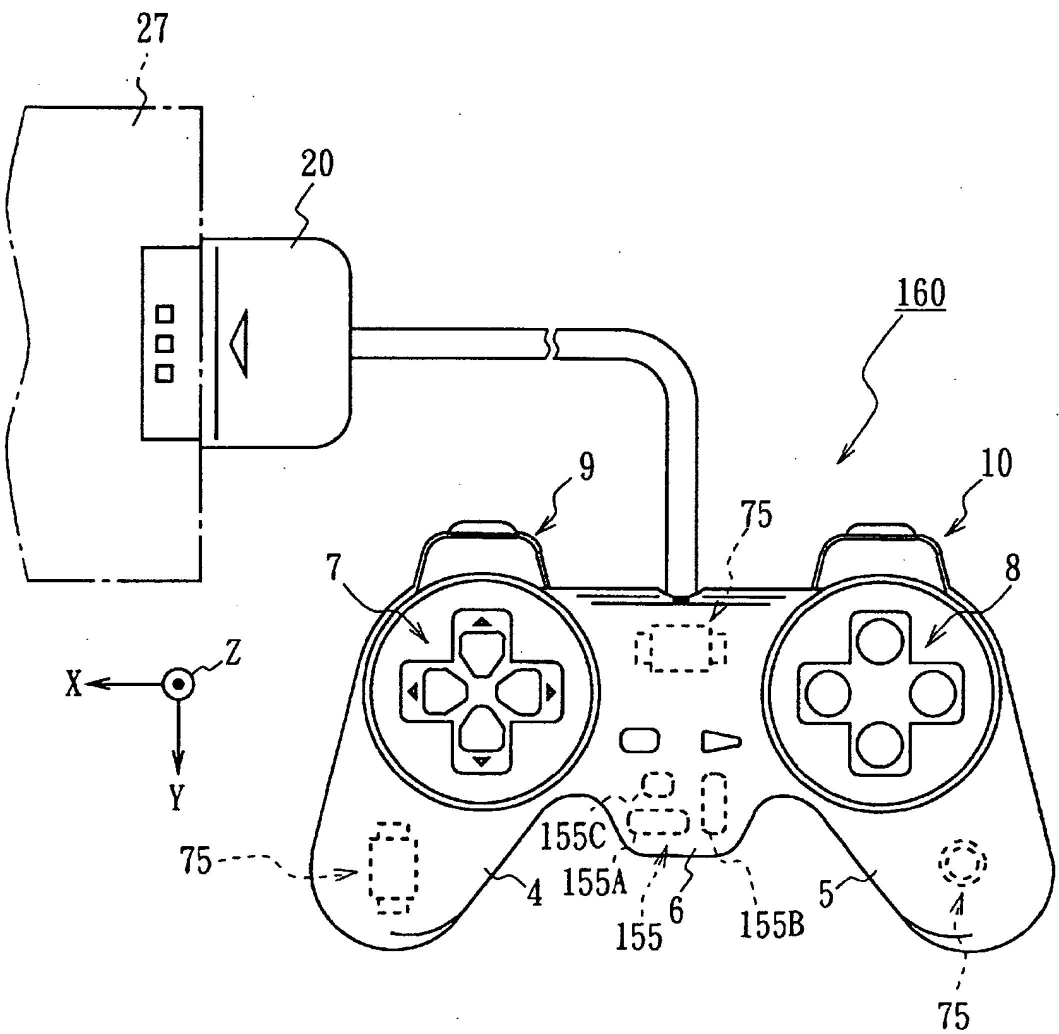


FIG. 52

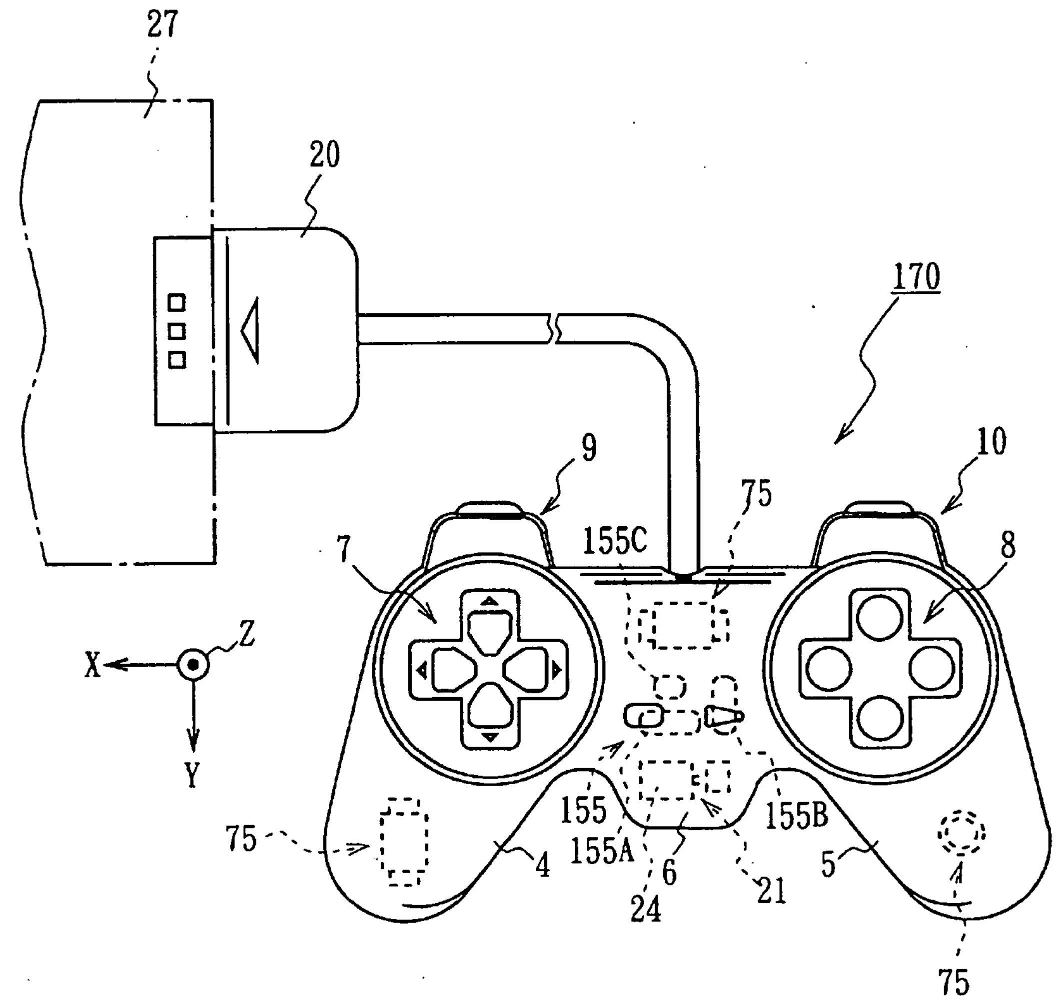


FIG. 53

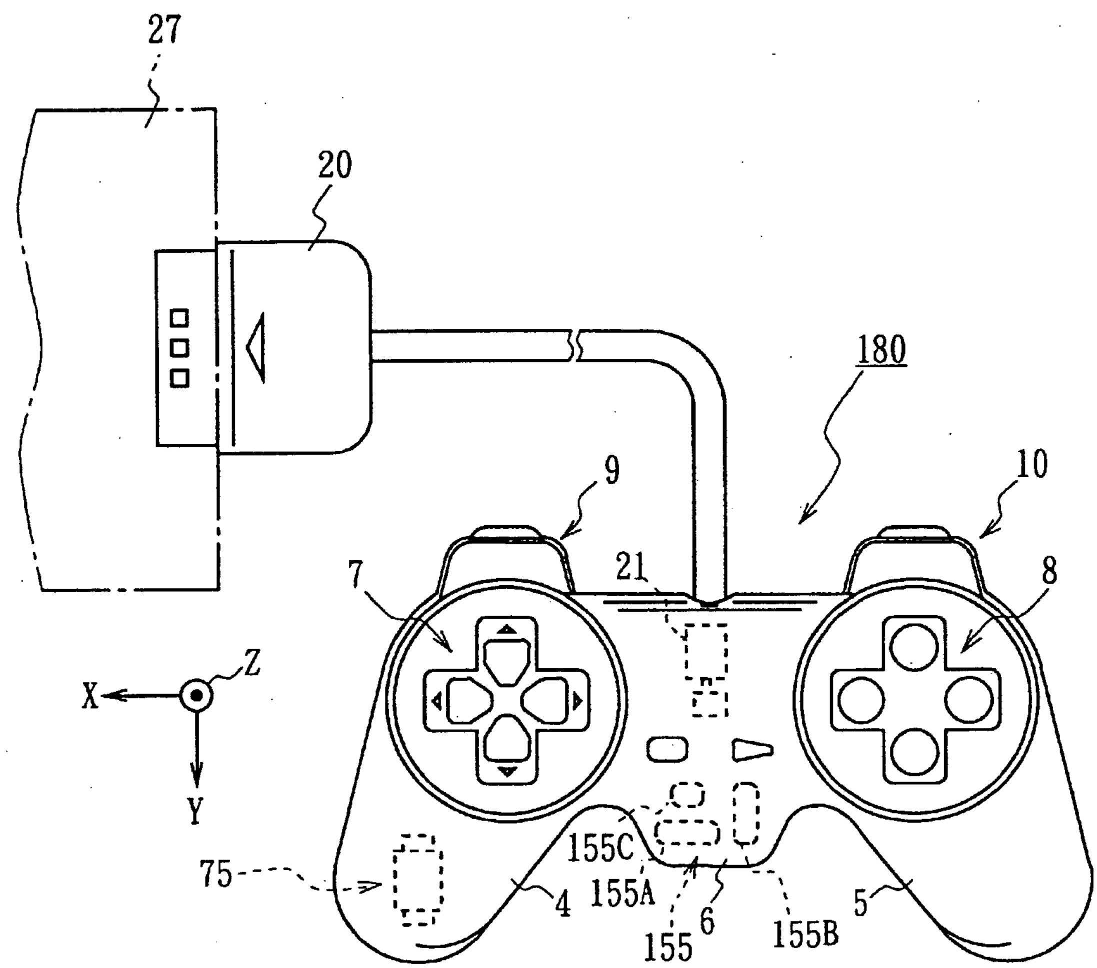


FIG. 54

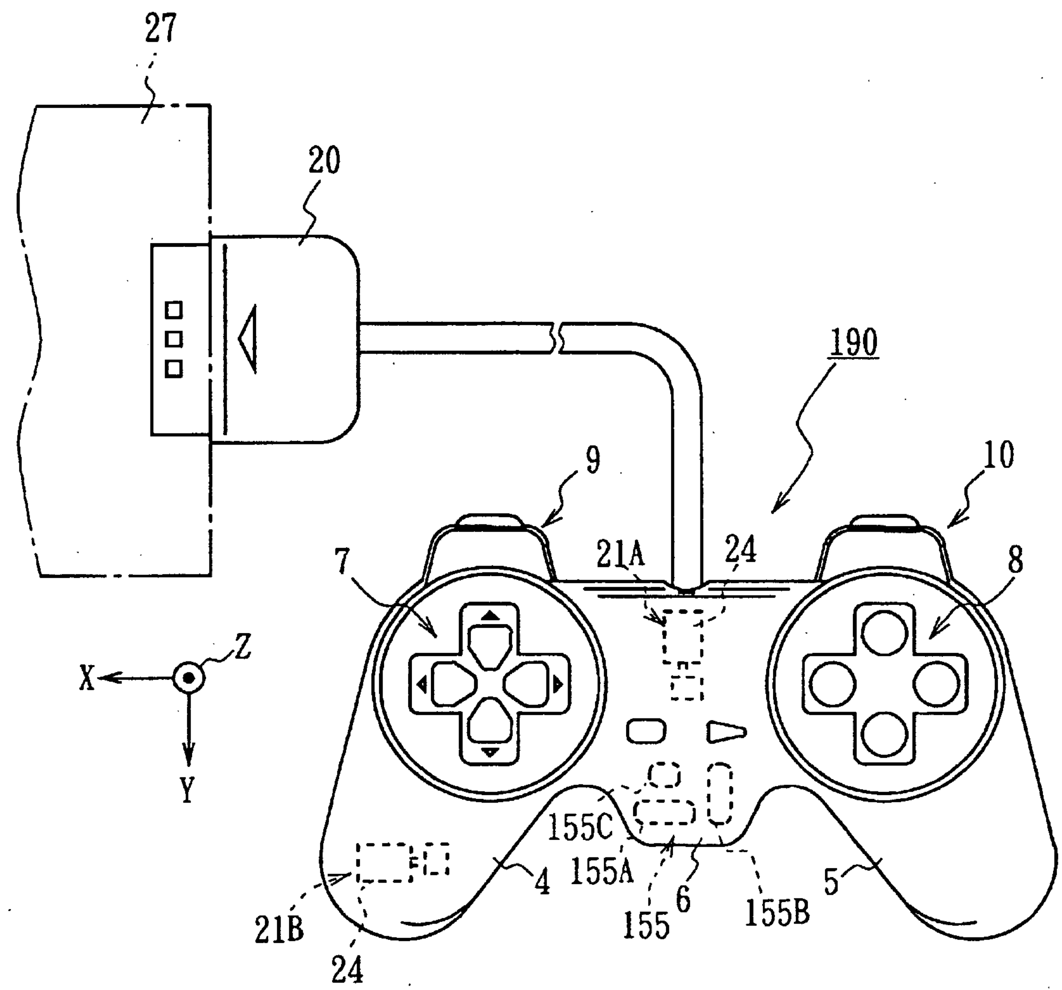


FIG. 55

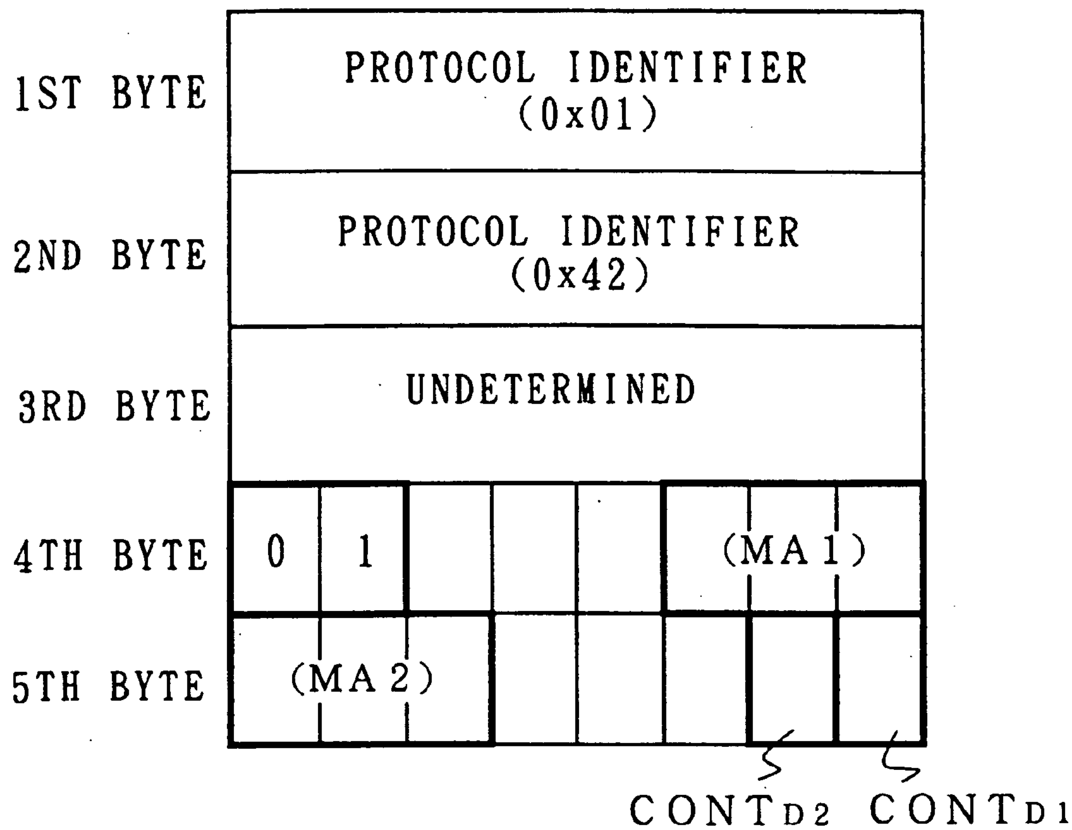

1ST BYTE
PROTOCOL IDENTIFIER (0x01)
2ND BYTE
PROTOCOL IDENTIFIER (0x42)
3RD BYTE
UNDETERMINED
4TH BYTE
0
1
(MA1)
5TH BYTE
(MA2)
CONTD2
CONTD1

FIG. 56

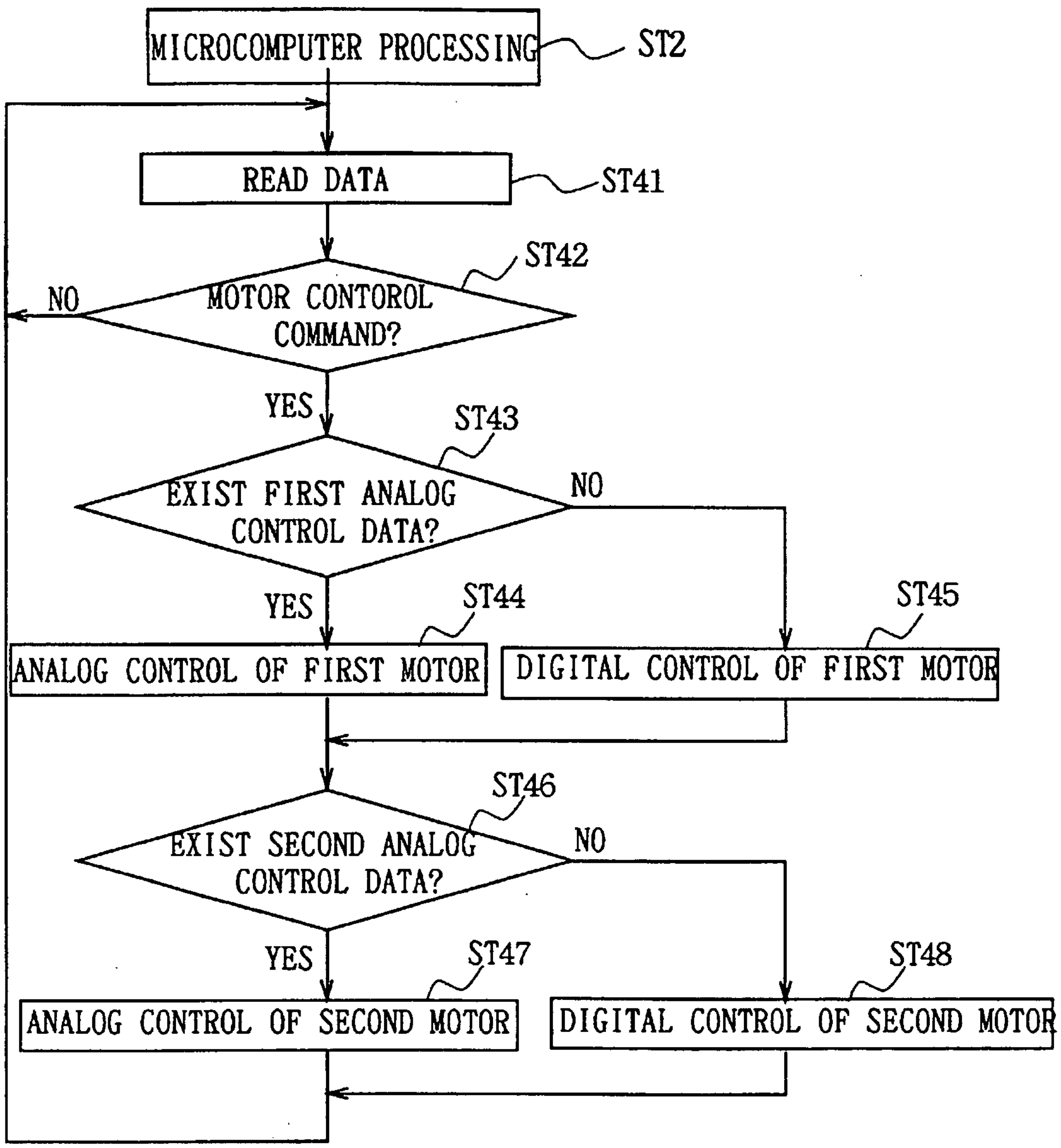

MICROCOMPUTER PROCESSING
ST2
READ DATA
ST41
ST42
NO
MOTOR CONTOROL COMMAND?
YES
ST43
EXIST FIRST ANALOG CONTROL DATA?
NO
YES
ST44
ST45
ANALOG CONTROL OF FIRST MOTOR
DIGITAL CONTROL OF FIRST MOTOR
ST46
EXIST SECOND ANALOG CONTROL DATA?
NO
YES
ST47
ST48
ANALOG CONTROL OF SECOND MOTOR
DIGITAL CONTROL OF SECOND MOTOR

FIG. 57

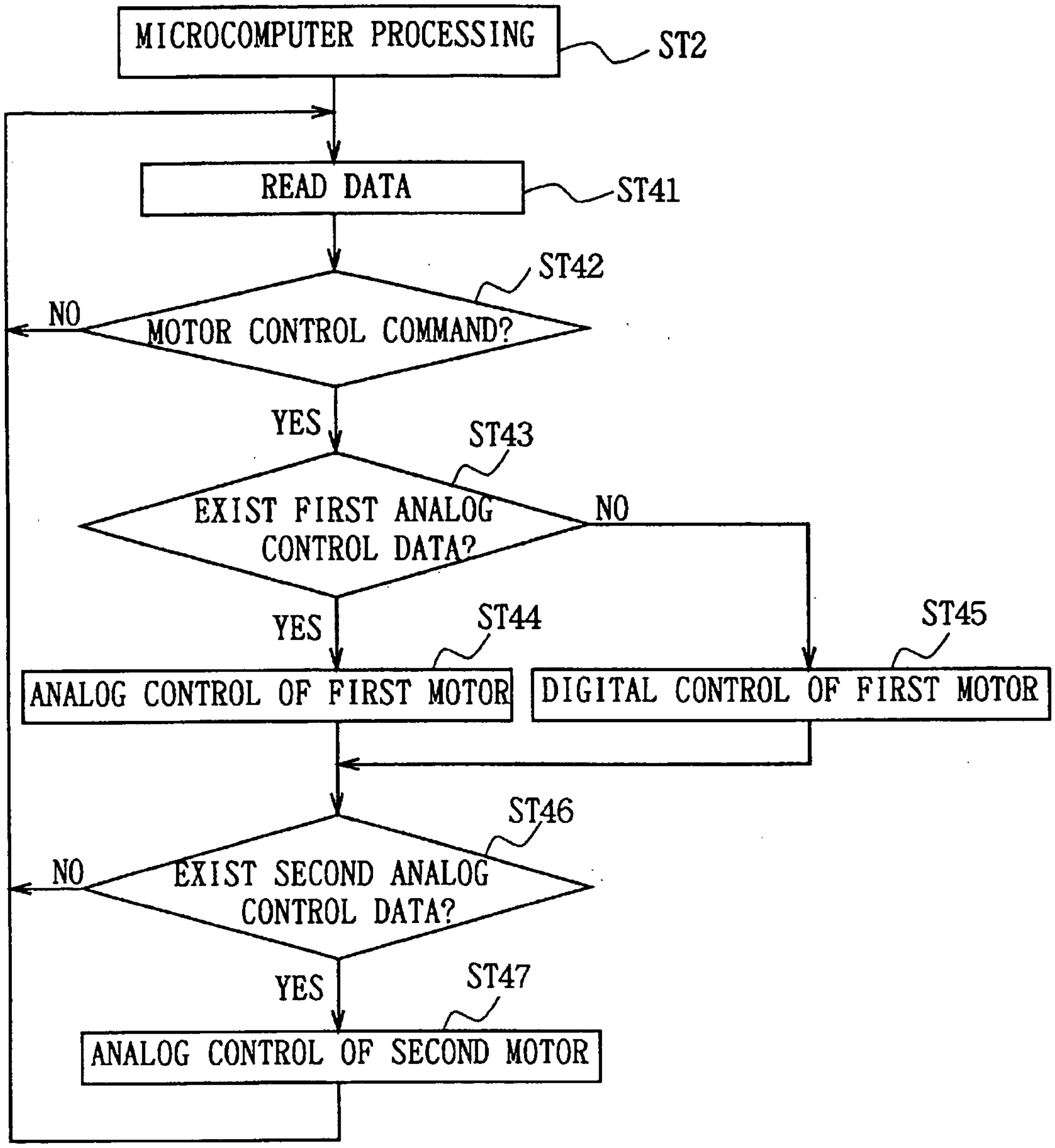

MICROCOMPUTER PROCESSING
ST2
READ DATA
ST41
ST42
NO
MOTOR CONTROL COMMAND?
YES
ST43
EXIST FIRST ANALOG CONTROL DATA?
NO
YES
ST44
ST45
ANALOG CONTROL OF FIRST MOTOR
DIGITAL CONTROL OF FIRST MOTOR
ST46
NO
EXIST SECOND ANALOG CONTROL DATA?
YES
ST47
ANALOG CONTROL OF SECOND MOTOR

FIG. 58

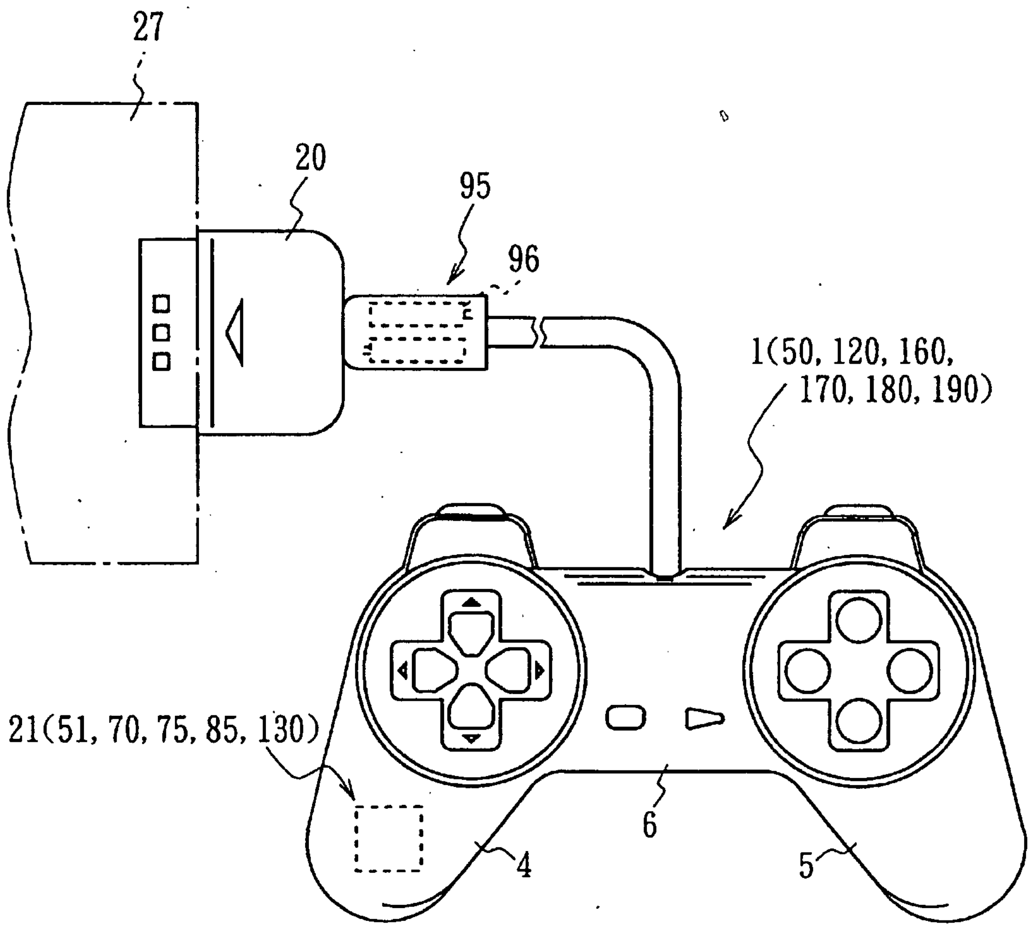


FIG. 59

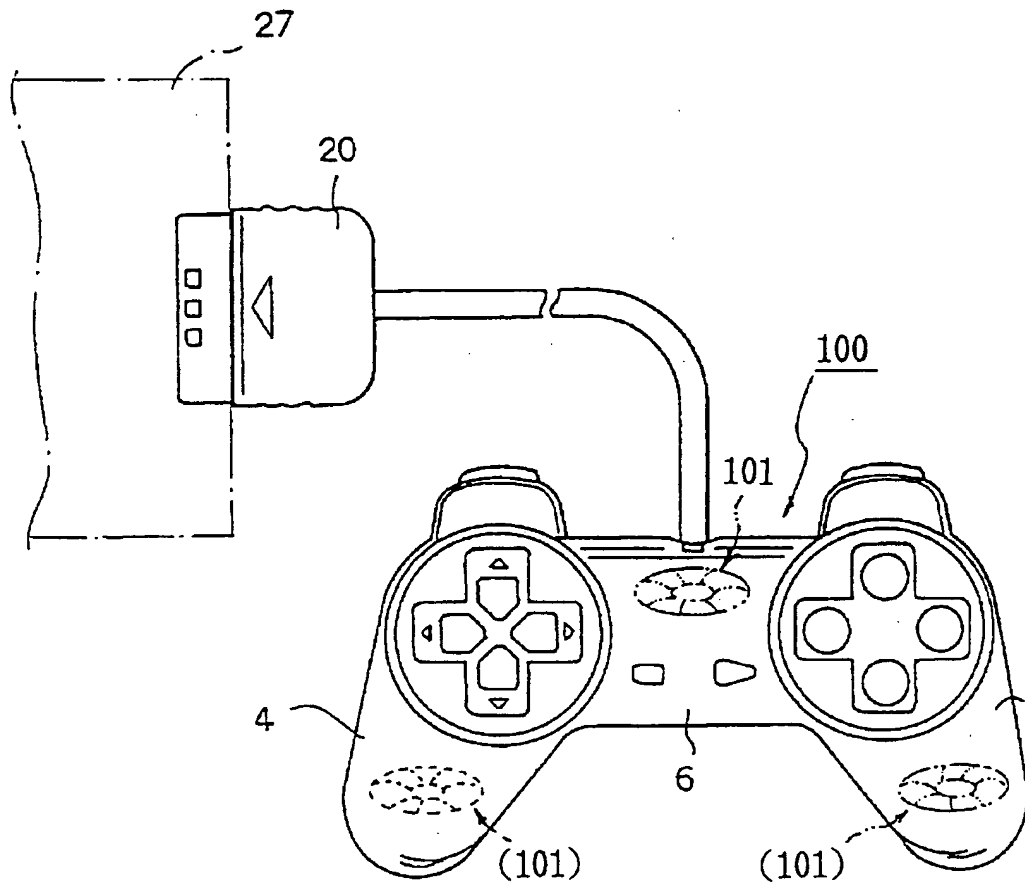


FIG. 60

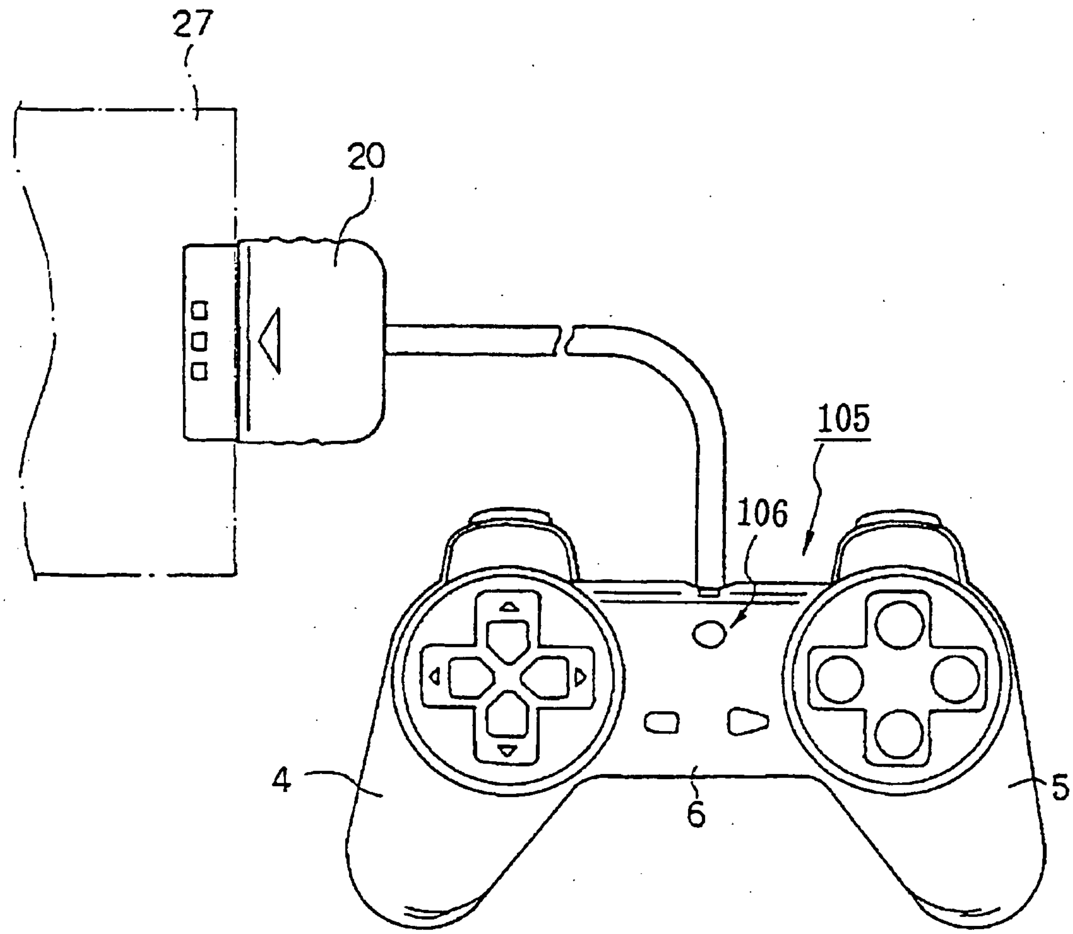


FIG. 61

GAME MACHINE CONTROL MODULE AND GAME MACHINE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a game machine control module for playing a game through operation of a plurality of buttons, and a game machine, and more particularly, to a game machine control module having a function causing ambience based on a specific signal from a game machine body that has a function for reproducing a video recording medium and such game machine.

2. Description of the Related Art

A game machine control module CM of prior art is formed in a form of glasses, as shown in FIG. 1, and has a housing comprising an upper case 2 and a lower case 3, which can be vertically separated. The housing is formed with first and second controller supports 4 and 5 at the longitudinal ends thereof that project in a square shape, and that are gripped by the palms of the hands for support. A start/select section 6 is formed on a constricted portion at the center of the housing, the section containing switches to start and select a game. Moreover, circular projections are formed at bilateral symmetric ends of the housing, and comprise first and second control sections 7 and 8 consisting of a plurality of switches disposed substantially at the center of each projection, as well as third and fourth control sections 9 and 10 having a plurality of switches disposed at bilateral positions on the front side wall surface of the housing, and that can be operated mainly by the forefingers and the middle fingers.

The start/select section 6 comprises so-called switches that include a start switch 11 and a select switch 12 disposed at an intermediate position between the first and second control sections 7 and 8. The select switch 12 is, for example, to select difficulty of a game when it is begun, while the start switch 11 is a switch for actually stating the game.

The first control section 7 comprises a recess 13 that is recessed in a substantially cross shape at the center of the circular projection at one end of the housing, and a window 15 in the recess 13 through which four key tops 14*a*, 14*b*, 14*c*, and 14*d* can be outwardly projected from inside. The window 15 is arranged with the upper ends of four key tops 14*a*, 14*b*, 14*c*, and 14*d* in a cross shape for the substantially cross-shaped recess 13.

The second control section 8 is provided, as shown in FIG. 1, with a recess 16 that is recessed in a substantially cross shape at the center of the circular projection at the other end, and four cylinders 17 with openings with size that allows cylindrical key tops 16*a*, 16*b*, 16*c*, and 16*d* to outwardly project from inside at respective corners of the cross-shaped recess 16.

The top surfaces of four key tops 16*a*, 16*b*, 16*c*, and 16*d* are marked with visually identifiable marks such as "○", "Δ", "□", and "X" for indicating functions so that the functions of the respective switches can be easily identified. In addition, the lower ends of these key tops 16*a*, 16*b*, 16*c*, and 16*c*, and the lower portion of the cylinder 17 are provided with unique projections or notches so that they do not engage other cylinders 17 when they are assembled.

The third and fourth control sections 9 and 10 are formed, as shown in FIG. 1, to bulge from the front wall of the first and second control sections 7 and 8, and comprises an opening 18 consisting two rows of elongated holes vertically parallel to the bulged wall, and a motion instructing control switch that is formed by projecting key tops 19*a*, 19*b*, 19*c*, and 19*d* with an elongated shape substantially fitting in the opening 18.

The game machine control module CM with such arrangement is connected to a video machine for reproducing a CD-ROM (not shown), a video recording medium, through a predetermined connector, and the video machine is connected to a monitor such as a TV receiver. Then, the control module is held by the palms of both hands, and the control buttons on the first to fourth control sections 7, 8, 9, and 10 are operated by the fingers of both hands to instruct motion of an action target such as a character on the monitor screen for playing the game.

However, the above-mentioned control module CM particularly for a household game machine is arranged to play the game by instructing motion of an action target on the monitor screen through operation of the buttons on the first to fourth control sections with the fingers, and the user can only perceive the character on the monitor screen by viewing it, or through visual sensation, and by hearing sound generated from the character, or through hearing sense. Thus, the control module itself does not have bodily sensation through feedback because the control module is operated by variously moving both hands and arms, but only substantially exploits a function for instructing one direction through operation with the fingers.

SUMMARY OF THE INVENTION

In view of the foregoing, an object of this invention is to provide a game machine control module and a game machine wherein game performance can be improved by enhancing ambience through an arrangement so that bodily sensation fed back from the game machine body can be obtained by the control module itself.

The foregoing object and other objects of the invention have been achieved by the provision of a game machine control module having a plurality of operation buttons, which is connected to a game machine body through cable. The game machine control module comprises: a control member for transmitting the operation data obtained by a plurality of the operation buttons to the game machine body through the cable, and for receiving the data containing a predetermined dynamic transmission data from the game machine body through the cable; and a response member which is positioned at a predetermined place on the game machine control module and which is operated by the control member based on the predetermined dynamic transmission data.

Further, according to this invention, the game machine control module having a plurality of operation buttons, which is connected to a game machine body through cable, comprises: a control member for transmitting the operation data obtained by a plurality of the operation buttons to the game machine body through the cable, and for receiving the data containing a predetermined dynamic transmission data, which further contains a plurality of control data, from the game machine body through the cable; and a response member which is positioned at a predetermined place on the game machine control module and which is operated by the control member based on the predetermined dynamic transmission data, the response member being controlled by the control member based on a plurality of the control data so as to selectively generate the difference action.

The nature, principle and utility of the invention will becomes more apparent from the following detailed descrip-

tion when read in conjunction with the accompanying drawings in which like parts are designated by like reference numerals or characters.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. **1** is an entire perspective view showing the arrangement of a control module according to the prior art;

FIG. **2** is a perspective view of an entire game machine control module according to the present invention with the lower case removed;

FIG. **3** is a perspective view of a motor and an eccentrically mounted rotary section that constitute a response member assembled in the control module;

FIG. **4** is a right side view showing a state where the control module is vibrating;

FIG. **5** is a schematic plan view showing a position where the response member to be assembled in the control module is assembled;

FIG. **6** is a schematic diagram showing a state to play a game by connecting the control module to the game machine body, and connecting the game machine body to a monitor;

FIG. **7** is a block diagram showing essential areas for performing bidirectional serial communication between the control module and the game machine body;

FIG. **8** is a flowchart showing processing procedure for data from the game machine control module;

FIG. **9** is a flowchart showing processing procedure for data from the game machine body;

FIGS. **10A** and **10B** are a schematic diagram and a waveform showing data of current value applied to a motor and a current waveform, respectively;

FIG. **11** is a right side view showing a control support according to an alternate embodiment;

FIG. **12** is a plan view showing the internal arrangement of the control support according to the alternate embodiment;

FIG. **13** is a sectional view taken along line A—A of FIG. **12**;

FIG. **14** is a partial plan view showing the control support according to the alternate embodiment;

FIG. **15** is a partial sectional view showing the internal arrangement of the control support of FIG. **14**;

FIG. **16** is a perspective view showing the arrangement of a second embodiment of the game machine control module according to the present invention;

FIG. **17** is a perspective view showing the arrangement of a response member according to the second embodiment;

FIG. **18** is a sectional view showing the arrangement of a response member according to the second embodiment;

FIGS. **19A** and **19B** are sectional views used for illustrating the operation of the response member according to the second embodiment;

FIGS. **20A** and **20B** are signal waveforms showing drive current waveforms of a vibrator;

FIG. **21** is a right side view showing a vibrating state of the control module according to the second embodiment;

FIG. **22** is a plan view showing the arrangement of a vibrator according to the second embodiment;

FIG. **23** is a schematic diagram showing an operation state the game machine according to the second embodiment;

FIG. **24** is a block diagram showing connections of the game machine body and the game machine control module;

FIG. **25** is a flowchart showing processing procedure on the game machine control module;

FIG. **26** is a flowchart showing processing procedure on the game machine body;

FIGS. **27A** and **27B** are schematic diagrams and a waveform showing data of current value applied to a coil and a current waveform, respectively;

FIG. **28** is a sectional view showing another embodiment of the response member;

FIG. **29** is a perspective view showing the another embodiment of the response member;

FIG. **30** is a sectional view showing still another embodiment of the response member;

FIG. **31** is a perspective view showing yet another embodiment of the response member;

FIGS. **32A** and **32B** are perspective views showing further another embodiments of the response member;

FIG. **33** is a right side view showing a vibrating state of the game machine control module according to an alternate embodiment;

FIG. **34** is a plan view showing the internal arrangement of the game machine control module according to the alternate embodiment;

FIG. **35** is a sectional view taken along line A—A of FIG. **33**;

FIG. **36** is a plan view showing the game machine control module according to the alternate embodiment;

FIG. **37** is a partial sectional view showing the arrangement of the vibrator according to the alternate embodiment;

FIG. **38** is a perspective view showing the arrangement of the game machine control module according to a third embodiment;

FIG. **39** is a perspective view showing the arrangement of the response member according to the third embodiment;

FIG. **40** is a perspective view showing the arrangement of the vibrator member according to the third embodiment;

FIG. **41** is a side view showing a vibrating state of the control module by vibration of the vibrating member;

FIG. **42** is a plan view showing the arrangement of the response member;

FIG. **43** is a plan view showing another arrangement of the response member;

FIG. **44** is a plan view showing an operating state of the game machine;

FIG. **45** is a block diagram showing a connection of the game machine body and the control module according to the third embodiment;

FIG. **46** is a perspective view showing the arrangement of an angular velocity sensor;

FIG. **47** is a block diagram showing the arrangement of a Z-axis angular velocity sensor;

FIG. **48** is a schematic diagram showing serial communication data according to the third embodiment;

FIG. **49** is a schematic diagram showing serial communication data according to the third embodiment;

FIG. **50** is a flowchart showing processing procedure on the game machine control module according to the third embodiment;

FIG. **51** is a flowchart on the game machine body according to the third embodiment;

FIG. **52** is a plan view showing the arrangement of an independent response member;

FIG. 53 is a plan view showing an example of combination of a voice coil and a motor;

FIG. 54 is a plan view showing an example of combination of a voice coil and a motor;

FIG. 55 is a plan view showing the arrangement of a plurality of response members using motors;

FIG. 56 is a schematic diagram showing serial communication data for the response member using a motor;

FIG. 57 is a flowchart showing microprocessor processing procedure on the control module;

FIG. 58 is a flowchart showing microprocessor processing procedure on the control module according to an alternate embodiment;

FIG. 59 is a plan view showing another embodiment of the power supply for the response member;

FIG. 60 is a plan view showing a game machine control module having a sound generator according to an alternate embodiment; and

FIG. 61 is a plan view showing a game machine control module having a light emitter according to an alternate embodiment.

DETAILED DESCRIPTION OF THE EMBODIMENT

Preferred embodiments of this invention will be described with reference to the accompanying drawings:

Description is given on various embodiments of a game machine control module used for a game machine according to the present invention by referring to the drawings. Here, for convenience of understanding, same reference numerals are used for components of the game machine control module used for the game machine according to the present invention having the same shapes of those described for the prior art, for which description is omitted.

(1) First Embodiment

A game machine control module **1** of a first embodiment according to the present invention has, as shown in FIG. **2**, a housing formed in a form of glasses and comprising first control support and second control supports **4** and **5** gripped and supported by the palms of both hands that are squarely projected at the longitudinal ends. The housing has, on a constricted portion at its center, a start/select section **6** on which buttons used for starting and selecting a game are formed to outwardly projecting from inside; first and second control sections **7** and **8** that have buttons outwardly projecting from inside at the top of both longitudinal ends of the housing; and third and fourth control sections **9** and **10** that comprise buttons outwardly projecting from inside on the wall at the front of both longitudinal sides of the housing. In addition, there are provided switches (not shown) mounted in the housing, and a board controlling communication with the game machine that contains a CD-ROM (not shown), a video recording medium, and can reproduce it. Furthermore, there is provided a connector **20** having a cable for electrically connecting the game machine (see FIG. **5**). The housing has a response member **21** located in a predetermined space. Among them, only difference from the prior art described in conjunction with FIG. **1** is provision of the suitable response member **21**, and all other components have structures and arrangements similar to those of the prior art.

That is, the housing consists of an upper case **2** and a lower case **3**, and provided with a response member positioning section **22** for mounting the response member **21** at a first control support **4** that is squarely projected on the lower case **3**.

The first and second control sections **7** and **8** on the lower case **3** are provided, as shown in FIG. **2**, with cylindrical mounting sections **23** for mounting a board and switches, and the rectangular third and fourth control sections **9** and **10** projected from the front surface of the first and second controls **7** and **8**.

In the lower case **3** thus constructed, available spaces for positioning the response member **21** are, as shown in FIGS. **2** and **5**, those existing at the locations of the first and second control supports **4** and **5** supported by the palms, or at the front of the constricted start/select section **6**. The embodiment is constructed to contain and position the response member **21** in the first control support **4** supported by the palm of the left hand.

Here, the response member **21** comprises, as shown in FIG. **3**, a motor **24** and a column-shaped rotating member **26** the rotating shaft **25** of which is mounted on the motor with off center, that is, eccentrically mounted thereon. With such arrangement, when the motor **24** rotates, the rotating member **26** causes eccentric rotation to generate vibration. This vibration is a sort of dynamic transmission. In FIGS. **2** and **4**, the vibration not only transmits to the first control support **4**, but also to the casings of the lower and upper cases **3** and **2**, so that the entire machine is caused to vibrate. Magnitude of the eccentrically generated vibration can be arbitrarily varied by the number of revolution and torque of the motor **24** of the responsive member **21**, whereby magnitude of the vibration can be varied on the responsive member.

A response member positioning section **22** provided on a lower case **3** is mounted, as shown in FIG. **2**, on a location of the first control support **4** where the palm abuts, and can secure the motor **24** of the responsive member **21**.

As the motor **24** of the responsive member **21** is mounted through rubber (not shown) on the first control support **4** of the case **3**, or the location gripped and supported by the palm, in playing a game by connecting the game machine control module **1** and the game machine **27** to a monitor **33** of a TV receiver or the like, as shown in FIG. **6**, the entire game machine control module **1** can be vibrated for a predetermined period of time by drivingly rotating the motor **24** of the response member **21** in response to a specific signal from the game machine **27** depending on the type of a game, for example, when the opponent is defeated in a grappling game, a target is shot in a shooting game, or an action target is an air plane and attacked on the screen. Thus, the game machine control module **1** itself vibrates through operation of the control button by the user to feed back it as bodily sensation to the user, so that ambience can be further improved. Mounting of the motor **24** through a rubber member (not shown) can reduce mechanical noise.

Here, the game machine **27** contains, as shown in FIG. **6**, a CD-ROM drive that has a function capable of reproducing a CD-ROM as a video recording medium, and has a lid member **28** on the top thereof for accepting and closing the CD-ROM. It further comprises a closing switch **29** for opening and closing the lid member **28**, a power switch **30** for supplying electric power, a reset switch **31** for initializing the operation of the game machine **27**, and a connection section **32** capable of connecting two sets of the control modules. When the connector **20** of the game machine control module **1** is connected to the connection section **32**, bidirectional communication can be established with the game machine **27**. While the embodiment is described for an arrangement where one set of the game machine control module **1** is connected, when two sets of the game machine control modules are connected, the operation and arrangement of the other control module are same, the description of which is omitted.

In order to vibrate the entire game machine control module 1 by driving the motor 24 of the response member 21 as described above, it is necessary to provide a function allowing bidirectional communication between the game machine control module 1 and the game machine 27.

The bidirectional communication function can be provided, as shown in FIG. 7, by connecting the connector 20 for bidirectional communication with the game machine control module 1 to the game machine 27.

An arrangement attaining the bidirectional communication function on the game machine control module 1 comprises a serial I/O interface SIO performing serial communication with the game machine 27, a parallel I/O interface PIO for inputting control data from a plurality of control buttons, a one-chip microcomputer consisting of a CPU, a RAM and a ROM (hereinafter called a microcomputer), and a motor driver 34 for driving and rotating the motor 24 of the response member 21. The motor 24 is rotated and driven by supply voltage and current from the motor driver 34.

The game machine 27 is provided with a serial I/O interface SIO for performing serial communication with the game machine control module 1. When the connector 20 of game machine control module 1 is connected, the serial I/O interface SIO is connected to the serial I/O interface SIO on the game machine control module 1 through the connector 20, whereby bidirectional communication or bidirectional serial communication can be established. Other detailed arrangement of the game machine 27 is omitted.

Signal and control lines for establishing the bidirectional serial communication include a signal line TXD (Transmit X' for Data) for data transmission for sending data from the game machine 27 to the game machine control module 1, a signal line RXD (Received X' for Data) for data transmission for sending data from the game machine control module 1 to the game machine 27, a signal line SCK (Serial Clock) for serial synchronization clock for extracting data from the respective data transmission signal lines TXD and RXD, a control line DTR (Data Terminal Ready) for establishing and interrupting communication of the game machine control module 1 as a terminal, and a control line DSR (Data Set Ready) for flow control for transferring a large amount of data.

In addition, a cable consisting of the signal and control lines for performing the bidirectional communication includes, as shown in FIG. 7, a power supply cable 35 directly led out from the power supply of the game machine 27 in addition to the signal and control lines. The power supply cable 35 is connected to the motor driver 34 on the game machine control module 1 to supply the electric power for rotating the motor 24.

In procedure for the bidirectional serial communication with such arrangement, the game machine 27 as shown in FIG. 5, for example, first outputs selection data on the control line DTR to cause the game machine 27 to communicate with the game machine control module 1, and to capture control data (button information) of the control buttons of the first to fourth control sections 7, 8, 9, and 10. Consequently, the game machine control module 1 confirms selection by the control line DTR, and waits for reception of a subsequent signal from the signal line TXD. Then, the game machine 27 issues an identification code identifying the game machine control module 1 to the data transmission signal line TXD. Thus, the game machine control module 1 receives the identification code through the signal line TXD.

As the identification code identifies the game machine control module 1, communication is started with the game machine 27 since then. That is, the game machine 27 sends control data or the like to the game machine control module 1 through the data transmission signal line TXD, whereas the game machine control module 1 sends control data from control by the control buttons or the like to the game machine 27 through the data transmission signal line RXD. In this manner, the bidirectional serial communication is performed between the game machine 27 and the game machine control module 1. This communication is terminated when the game machine 27 outputs selection discontinue data through the control line DTR.

As described, if the bidirectional serial communication function is provided, the game machine control module 1 can send control data mainly from the control buttons to the game machine 27, while the game machine 27 can deliver to the game machine control module 1 dynamic transmission data for rotating the motor 24 of the response member 21. The dynamic transmission data for rotating the motor 24 is preset by a game CD-ROM loaded on the game machine 27, and feedback is performed by the dynamic transmission in a predetermined period of time from the game machine 27 to the game machine control module 1 itself depending on an action target of the game player. This is described in detail in conjunction with the flowcharts of FIGS. 8 and 9 by referring to FIGS. 2 and 7.

The user loads a specific game CD-ROM in the game machine 27, sets start of the game with the start switch 11 of the game machine control module 1 shown in FIG. 2, and sets various functions through operation of the select switch 12, whereby the game is ready for play through operations of the first to fourth control sections 7, 8, 9, and 10.

Then, as the game is started, the microcomputer of the game machine control module 1 consisting of the CPU, the RAM and the ROM shown in FIG. 7 continuously monitors through the serial interface SIO that dynamic transmission data for hit is sent from the game machine 27 through the serial I/O interface SIO. The dynamic transmission data contains a control signal for voltage and current for driving the motor 24 shown in FIG. 7, and duration for driving the motor 24. Then, as the game progresses, if there is the dynamic transmission data in data sent from the game machine 27, it drives the motor driver 34, and supplies the voltage supplied from the game machine 27 to the motor 24 for a predetermine period of time. That is, step ST21 in FIG. 8 determines the dynamic transmission data in the data signal received by the game machine control module 1 in step ST21, step ST2 processes it with the microcomputer, step ST3 drives the motor driver 34 shown in FIG. 7, and step ST4 generates vibration.

In addition, if step ST1 determines that it is not the dynamic transmission data, when the control button is operated in step ST5, step ST6 inputs the operated control data to the microcomputer through the parallel I/O interface PIO shown in FIG. 7.

The control data input in the microcomputer is processed by the microcomputer in step ST2, and converted into serial data in step ST7, and sent to the game machine 27 through the serial I/O interface SIO shown in FIG. 7. Thereafter, the game machine control module 1 waits for data from the game machine 27 in step ST25.

When the game machine 27 receives the control data converted into serial data in step ST26 shown in FIG. 9, and subsequent step ST8 compares data of the action target and the received serial data to determine a hit state.

If the data of the action data matches the serial data in step ST9, that is, if a hit is detected, in step ST10, the hit action target is displayed on the monitor screen, and the dynamic transmission data is output in step ST11, converted into

serial data in step ST12, sent as a specific response signal to the game machine control module 1 through the serial I/O interface SIO shown in FIG. 7. Subsequently, the game machine 27 waits for data from the game machine control module 1 in step ST27. When the microcomputer of the game machine control module 1 detects the dynamic transmission returned from the game machine 27 to the game machine control module 1, as described in conjunction with steps ST1, ST2, and ST3, electric power is supplied from the motor driver 34 shown in FIG. 7 to the motor 24 for rotation. Such rotation vibrates the entire game machine control module 1.

If there is no hit, the action target based on the control button is displayed on the screen of the monitor in step ST13, and the next action would be performed according to the result of operation of the control button from the game machine control module 1 by step ST5 (FIG. 8).

In addition, while it is arranged that the dynamic transmission data generated at a hit as described above is received as a specific response signal by the game machine control module 1, the arrangement may be to send it from the game machine 27 to the game machine control module 1 via mono-directional communication.

Here, FIG. 10A particularly shows packet data PA for rotating and driving the motor 24 among the dynamic transmission data sent from the game machine 27 to the game machine control module 1. In this embodiment, one packet is constituted by four current value data. Respective microcomputer of the game machine 27 and the game machine control module 1 process data in every 1/60 seconds (one frame). Accordingly, the packet data PA is also sent from the game machine 27 to the game machine control module 1 in every 1/60 seconds.

Therefore, the drive current value applied to the motor 24 can be varied by the number of current value data in one frame interval by distributing the four current value data in one packet to one frame interval in every 1/4 frame interval.

In other words, the dynamic transmission data transferred from the game machine 27 to the game machine control module 1 in a frame interval is data processed by the microcomputer of that game machine control module 1, whereby the packet data PA is read out. In the case of FIGS. 10A and 10B, four current value data "2", "3", "5", and "3" are read out as the packet data PA, converted into analog signals, and delivered to the motor driver 34 which will be described later in conjunction with FIG. 23.

The motor driver 34 obtains a drive current signal SD shown in FIGS. 10A and 10B by analog amplifying the values converted into analog signals with the electric power supplied from the game machine 27. The drive current signal SD corresponds to the current value data "2", "3", "5", and "3" of the packet data PA. It becomes a current value corresponding to the first current value data "2" for the beginning 1/4 frame (time t11–t12) interval in the first frame interval FL1 (time t11–t15), a current value corresponding to the second current value data "3" for the 1/4 frame following the beginning 1/4 frame (time t12–t13), a current value corresponding to the third current value data "5" for the 1/4 frame following it (time t13–t14), and a current value corresponding to the fourth current value data "3" for the last 1/4 frame (time t14–t15) provided from the coil driver 64 to the coils 58 and 59.

Even if the transfer timing is every 1/60 seconds for the dynamic transmission data transferred from the game machine 27 to the game machine control module 1, it is possible to contain and transfer a plurality of current value data (four for the embodiment) in the packet for that dynamic transmission data, whereby the game machine control module 1 can distribute the plurality of current value data in one frame interval and obtain a drive current signal SD.

Consequently, the motor 24 is driven by the drive current signal SD that varies in a time interval shorter than the time interval (one frame interval) where the dynamic transmission data is sent. In this manner, it is possible to set the frequency of the vibrator 53 by arbitrarily varying the waveform of the drive current signal SD with a shorter time interval and various current value data, while acceleration can be set for the rotation of the motor 24 by the current value.

Incidentally, various values are set for the current value data set for the packet data PA depending on magnitude of impact applied on an action target during progress of the game. In this case, various numbers in addition to four are assigned as the number of current value data assigned to one packet. Therefore, various drive current waveform are set according to progress of the game, whereby a high current value is applied to the motor 24 for a short period of time, for example, in a scene where a high impact is applied to the action target, so that vibration of high speed rotation such as an impact is generated on the game machine control module 1. On the other hand, in a scene where low and continuous vibration such as idling of a car is generated on the action target, a low current value is alternately applied to the motor 24 for a long period of time, whereby rotating vibration as if idling of a car is generated on the game machine control module 1.

Thus, when the response member 21 containing the motor 24 is used, vibration similar to vibration generated on a virtual action target is generated on the game machine control module 1 according to progress of the game played on the screen, whereby the user operating the game machine control module 1 can experience the game with ambience.

While description has been given on a case where a current value at each timing of rotary drive current applied on the motor 24 of the response member 21 is transferred from the game machine 27 to the game machine control module 1 in packet data, the present invention is not limited to this, but may be arranged in such a manner that data representing waveforms of drive current is transferred from the game machine 27 to the game machine control module 1, and current waveforms corresponding to the waveform data is generated on the game machine control module 1.

While, in the embodiment of the present invention described above, as shown in FIG. 5, the motor 24 of the response member 21 is arranged to be contained in the first control support 4 supported by the palm of the left hand, motors may be contained in at least two of spaces existing in the locations of the first and second control supports 4 and 5, and in front of the start/select section 6, or in all such spaces.

In addition, when the motors are mounted in at least two of spaces existing in the locations of the first and second control supports 4 and 5, and in front of the start/select section 6, or in all such spaces, it may be possible to mount motors or the response members 21 of the same size, or motors with different size (that is, motors generating different magnitude of vibration). Thus, when the motors with different size are mounted, they may be simultaneously or selectively vibrated, so that there is provided another advantage that the performance of the game can be further enhanced.

Now, an alternate embodiment is described for the control module using the response member with the motor 24 according to the present invention by referring to FIGS. 11 to 13.

The game machine control module 1 of this embodiment has a construction in which the response member 21 is expanded or deformed at the location supported by the palm, as shown in FIGS. 11 to 13. That is, the game machine control module 1 is constructed in such a manner that, for the first control support 4, parts of the portion supported by the palm of the left hand are cut away, resilient members 37A and 37B being mounted to close the cut-away parts, and deformed or expanded by relatively or partially pushing out them, whereby dynamic transmission is applied to the palm, or so-called bodily sensation of response is fed back.

Here, the resilient members 37A and 37B may be made of, for example, rubber members, resin members, or fabric members.

The response member 21 is substantially same as that of the first embodiment described in conjunction with FIG. 2 other than its structure and mounting, so that same reference numerals are used for description. The bidirectional serial communication is also performed in the similar technique.

The response member 21 is constructed by cutting away a part of the portion of the first control support 4 constituted by the upper and lower cases 2 and 3 to which the palm abuts, and mounting the resilient members 37A and 37B to close the cut-away portions. Then, it comprises therein, as shown in FIG. 12, a motor 38 being drivingly rotated, and a column-shaped rotating member 41 that is mounted on the rotating shaft 39 of the motor 38 and has a plurality of projections 40 at suitable positions. The resilient members 37A and 37B thus mounted have, as shown in FIG. 13, a structure longer in the longitudinal direction and shorter in the lateral direction at the portion of the first control support 4 where the palm abuts. Therefore, when the column-shaped rotating member 41 rotates, its projections 40 rotate to press the upper portion of the resilient member 37A of the upper case 2 and the lower portion of the resilient member 37B of the lower case 3 so that they are pushed out outward. This can generate vibration by causing the upper and lower portions of the portion of the first control support 4 where the palm abuts to deform or expand outward, and causing the projections 40 to beat the resilient members 37A and 37B, whereby ambience to the user can be enhanced by the feel and feedback function to the dynamic transmission to the palm, as shown in FIGS. 11 and 13.

In addition, description is given on the alternate embodiment of the control module using a response member with a motor 24 by referring to FIGS. 14 and 15.

The game machine control module 1 is arranged, as shown in FIGS. 14 and 15, so that the response member 21 provided on the game machine control module 1 is deformed or expanded. That is, the game machine control module 1 is constructed in such a manner that the first control support 4 supported by the palm of the left hand is formed by a resilient member 42 at a portion where the palm abuts, and mounted therein with a motor 43 and a cam-shaped rotating member 45 mounted on the rotating shaft 44 of the motor 43.

When the motor 43 is drivingly rotated, the cam-shaped rotating member 45 beats or presses the resilient member 42 from inside, causing it to outwardly bulge or deform and also to generate vibration. Its dynamic transmission is received by the palm as bodily sensation, so that ambience can be obtained.

While the two alternate embodiments of the present invention described above is arranged, as shown in FIG. 5, to contain and position in the first control support 4 supported by the palm of the left hand, the response member 21 of the present invention may be contained and positioned, as shown in FIG. 5, in the second control support 5 supported by the palm of the right hand.

In addition, while the two alternate embodiments of the present invention described above are arranged to contain and position the motor 43 of the response member 21 in the first control support 4 supported by the palm of the left hand, it may be contained and positioned, as shown in FIG. 5, in both the first and second control supports 4 and 5.

Furthermore, when the motors are positioned in both the first and second control supports 4 and 5, it may be possible to mount motors or the response members 21 of the same size, or motors with different size (that is, motors generating different magnitude of vibration). Thus, when the motors with different size are mounted, they may be simultaneously or selectively vibrated, so that there is provided another advantage that the performance of the game can be further enhanced.

(2) Second Embodiment

FIG. 16 identifies components corresponding to those in FIG. 2 with the same reference numerals, and shows a second embodiment of the game machine control module according to the present invention, wherein a response member 51 is mounted on a response member positioning section 52 formed in the first control support 4 of the lower case 3. The response member 51 has a linearly reciprocating vibrator 53.

That is, as shown in FIG. 17, the response member 51 of the second embodiment forms the vibrator 53 by securing a weight 63 substantially at the center of a cylindrical coil bobbin 57, and forms a stator 54 with two magnetic members 55 and 56 that cause the vibrator 53 to reciprocate and oscillate in the axial direction of the coil bobbin 57.

Conductive wires are wound around each end of the coil bobbin in the opposite direction to form a first coil 58 and a second coil 59. The coil bobbin 57 thus mounted with the coils 58 and 59 on each end are loosely inserted with both ends into loose fitting holes 55E and 56E (FIG. 17) drilled in the magnetic members 55 and 56, and is supported so that it can be reciprocated by a hanger 60 consisting of a support member 61 and a leaf spring 62.

FIG. 18 shows a sectional view of the response member 51 in which two magnetic members 55 and 56 forming the stator 54 have substantially column-shaped outer shapes, and projectingly formed with column-shaped magnetic poles (S poles) 55A and 56A along their axes. The magnetic members 55 and 56 are formed by inserting and securing a core 64 between these two magnetic poles 55A and 56A. Here, members connected with the magnetic members 55 and 56 is not limited to be the core 64, but may be nonmagnetic resin members.

In addition, ring-shaped projecting magnetic poles (N poles) 55B and 56B are formed at opposite positions with a predetermined interval on the peripheral surfaces of the magnetic poles 55A and 56A, respectively. Accordingly, the magnetic member 55 has magnetic flux density B in the gap between the magnetic poles 55A and 55B (loose fitting hole 55E), while the magnetic member 56 has magnetic flux density B in the gap between the magnetic poles 56A and 56B (loose fitting hole 56E). The loose fitting hole 55E in the magnetic member 55 is loosely fitted with one end of the coil bobbin 57 that forms the vibrator 53, and a coil 58 wound around that end is positioned to cross the magnetic flux. In addition, the magnetic member 56 is similarly arranged so that the other end of the coil bobbin 57 is loosely fitted into the loose fitting hole 56E, and a coil 59 wound around that end is positioned to cross the magnetic flux.

Here, as shown in FIG. 19A, an initial state is assumed that the end formed with the coil 58 of the vibrator 53 is moved to the left to abut the magnetic member 55. When

drive current I58 as shown in FIG. 20A is applied to the coil **58**, and drive current I59 as shown in FIG. 20B is applied to the coil **59**, in the initial state (time t=0), the drive current I_{58} flows through the coil **58**, but the drive current I_{59} does not flow through the coil **59**.

Thus, force $F=I_{58}\times B$ acts on the coil **58**, whereby the vibrator **53** moves to the right (that is, the direction toward the magnetic member **56**), and, as shown in FIG. 19B, the end of the vibrator **53** formed with the coil **59** stops at a position where it abuts the magnetic member **56**.

Then, at the time where t=T, the drive current I_{59} flows through the coil **59**, as shown in FIG. 20B, and the drive current I_{58} does not flow through the coil **58**, as shown in FIG. 20A. Therefore, as the winding direction is opposite on the coils **58** and **59**, force −F acts on the coil **59**. Consequently, the vibrator **53** moves to the left (that is, the direction toward the magnetic member **55**), and returns to the initial state shown in FIG. 19A.

Thus, the vibrator **53** reciprocates or oscillates between the magnetic members **55** and **56** by alternately applying the drive current I_{58} and I_{59} to the coils **58** and **59** in the similar manner.

Incidentally, when the cycles of the drive current I_{58} and I_{59} are changed, the oscillating frequency can be varied for the vibrator **53**, while, when the current values of I_{58} and I_{59} are changed, the force F (or, acceleration) acting on the vibrator **53** can be changed. In addition, when the magnetic members **55** and **56** is made larger in their size, the flux density B is increased, so that the force F acting on the vibrator **53** can be increased. In this case, when the magnetic members **55** and **56** are used as the stator **54**, unlike to the case where they are mounted on the vibrato, only mass of the stator is increased even if the magnetic members **55** and **56** are made larger, and mass of the vibrator remains unchanged, so that sufficient vibration in practical use can be generated.

Thus, when the vibrator **53** is vibrated by applying the drive current I_{58} and I_{59} (hereinafter collectively called the drive current I) to the coils **58** and **59**, the vibration is transmitted to the first control support **4** through the response member positioning section **52** securing the stator **54** on the lower case **2** (FIG. 16) (FIG. 21). The vibration transmitted to the first control support **4** is transmitted not only to the first control support **4**, but also to the casing of the lower and upper cases **3** and **2**, so that the entire module is vibrated. Magnitude of the vibration generated by the vibrator **53** can be arbitrarily varied by the drive current I applied to the coils **58** and **59** of the response member **51**, whereby magnitude of the vibration can be varied on the responsive member **51**.

Incidentally, a space in which the response member **51** can be mounted may be the space in the positions of the first and second control supports **4** and **5** supported by the palms, or the space existing in front of the start/select section **6** defined between the two control supports **7** and **8**, as shown in FIGS. **16** and **22**. In the embodiment, it is contained and positioned in the first control support **4** supported by the palm of the left hand.

Thus, as the response member **51** is mounted in the first control support **4** of the lower case **3**, or the portion supported by the palm of the left hand, in playing a game by connecting the game machine control module **50** and the game machine **27** to a monitor **33** of a TV receiver or the like, as shown in FIG. **23**, the entire game machine control module **50** can be vibrated for a predetermined period of time by vibrating the vibrator **53** of the response member **51** in response to a specific signal from the game machine **27** depending on the type of a game, for example, when the opponent is defeated in a grappling game, a target is shot in a shooting game, or an action target is an air plane and attacked on the screen. Thus, the game machine control module **50** itself vibrates through operation of the control button by the user to feed back it as bodily sensation to the user, so that ambience can be further improved.

Here, the game machine **27** contains, as shown in FIG. **23**, a CD-ROM drive that has a function capable of reproducing a CD-ROM as a video recording medium, and has a lid member **28** on the top thereof for accepting and closing the CD-ROM. It further comprises a closing switch **29** for opening and closing the lid member **28**, a power switch **30** for supplying electric power, a reset switch **31** for initializing the operation of the game machine **27**, and a connection section **32** capable of connecting two sets of the control modules. When the connector **20** of the game machine control module **50** is connected to the connection section **32**, bidirectional communication can be established with the game machine **27**. The embodiment is described for an arrangement where one set of the game machine control module **50** is connected. When two sets of the game machine control modules are connected, the operation and arrangement of the other control module are same, the description of which is omitted.

In order to vibrate the entire game machine control module **50** bar vibrating the vibrator **53** of the response member **51** as described above, it is necessary to provide a function allowing bidirectional communication between the game machine control module **50** and the game machine **27**. The bidirectional communication function can be provided, as shown in FIG. **24**, by connecting the connector **20** for bidirectional communication with the game machine control module **50** to the game machine **27**.

An arrangement attaining the bidirectional communication function on the game machine control module **50** comprises a serial I/O interface SIO performing serial communication with the game machine **27**, a parallel I/O interface PIO for inputting control data from a plurality of control buttons, a one-chip microcomputer consisting of a CPU, a RAM and a ROM, and a motor driver **34** for vibrating the vibrator **53** of the response member **51**. The coils **58** and **59** of the vibrator **53** is vibrated by supply voltage and current from a coil driver **64**.

The game machine **27** is provided with a serial I/O interface SIO for performing serial communication with the game machine control module **50**. When the connector **20** of game machine control module **50** is connected, the serial I/O interface SIO is connected to the serial I/O interface SIO on the game machine control module **50** through the connector **20**, whereby bidirectional communication or bidirectional serial communication can be established. Other detailed arrangement of the game machine **27** is omitted.

Signal and control lines for establishing the bidirectional serial communication include a signal line TXD (Transmit X' for Data) for data transmission for sending data from the game machine **27** to the game machine control module **50**, a signal line RXD (Received X' for Data) for data transmission for sending data from the game machine control module **50** to the game machine **27**, a signal line SCK (Serial Clock) for serial synchronization clock for extracting data from the respective data transmission signal lines TXD and RXD, a control line DTR (Data Terminal Ready) for establishing and interrupting communication of the game machine control module **50** as a terminal, and a control line DSR (Data Set Ready) for flow control for transferring a large amount of data.

In addition, a cable consisting of the signal and control lines for performing the bidirectional communication includes, as shown in FIG. 23, a power supply cable **35** directly led out from the power supply of the game machine **27** in addition to the signal and control lines. The power supply cable **35** is connected to the coil driver **64** on the game machine control module **50** to supply the electric power for rotating the motor.

In procedure for the bidirectional serial communication with such arrangement, the game machine **27** as shown in FIG. **24**, for example, first confirm selection data on the control line DTR to cause the game machine **27** to communicate the game machine control module **50**, and to capture control data (button information) of the control buttons of the first to fourth control sections **7, 8, 9**, and **10**. Then, the game machine control module **50** waits for reception of a subsequent signal from the signal line TXD. Then, the game machine **27** issues an identification code identifying the game machine control module **50** to the data transmission signal line TXD. Thus, the game machine control module **50** receives the identification code through the signal line TXD.

As the identification code identifies the game machine control module **50**, communication is started with the game machine **27** since then. That is, the game machine **27** sends control data or the like to the game machine control module **50** through the data transmission signal line TXD, whereas the game machine control module **50** sends control data from control by the control buttons or the like to the game machine **27** through the data transmission signal line RXD. In this manner, the bidirectional serial communication is performed between the game machine **27** and the game machine control module **50**. This communication is terminated when the game machine **27** outputs selection discontinue data through the control line DTR.

As described, if the bidirectional serial communication function is provided, the game machine control module **50** can send control data mainly from the control buttons to the game machine **27**, while the game machine **27** can deliver to the game machine control module **50** dynamic transmission data for vibrating the vibrator **53** of the response member **51**. The dynamic transmission data for vibrating the vibrator **53** is preset by a game CD-ROM loaded on the game machine **27**, and feedback is performed by the dynamic transmission in a predetermined period of time from the game machine **27** to the game machine control module **50** itself depending on an action target of the game player. This is described in detail in conjunction with the flowcharts of FIGS. **25** and **26** designating components corresponding to those of FIGS. **7** and **8** with the same reference numerals by referring to FIGS. **16** and **24**.

The user loads a specific game CD-ROM in the game machine **27**, sets start of the game with the start switch **11** of the game machine control module **50** shown in FIG. **16**, and sets various functions through operation of the select switch **12**, whereby the game is ready for play through operations of the first to fourth control sections **7, 8, 9**, and **10**.

Then, as the game is started, the microcomputer of the game machine control module **50** consisting of the CPU, the RAM and the ROM shown in FIG. 24 continuously monitors through the serial interface SIO at step ST21 shown in FIG. **25** that dynamic transmission data for hit is sent from the game machine **27** through the serial I/O interface SIO. The dynamic transmission data contains a control signal for voltage and current for vibrating the vibrator **53** shown in FIG. **24**, and duration for vibrating the vibrator **53**. Then, as the game progresses, if there is the dynamic transmission data in data sent from the game machine **27**, it drives the coil driver **64**, and supplies the voltage supplied from the game machine **27** to the coils **58** and **59** of the vibrator **53** for a predetermine period of time.

That is, after step ST1 detects the dynamic transmission data in the data signal received by the game machine control module **50**, the microcomputer processes the dynamic transmission data in step ST2. Thee resulting dynamic transmission data is converted into an analog signal in step ST22, which in turn drives the coil driver **64** (FIG. **24**) in the following step ST23. Thus, the coil driver **64** supplies the drive current I to the coils **58** and **59** of the vibrator **53** to vibrate the vibrator **53** in step ST24.

In addition, if the data signal supplied to the game machine control module **50** from the game machine **27** is not the dynamic transmission data, the microcomputer of the game machine control module **50** proceeds from step ST1 of FIG. **25** to step ST5, and waits for operation of the control buttons. If affirmative acknowledgment is obtained here, it means that the control button of the game machine control module **50** is operated. In this case, the microcomputer proceeds to step ST6, and captures control data through the parallel I/O interface PIO.

The control data input in the microcomputer is processed by the microcomputer in step ST2 of FIG. **25**, and converted into serial data in step ST7, and sent to the game machine **27** through the serial I/O interface SIO (FIG. **24**). Thereafter, the game machine control module **50** waits for data from the game machine **27** in step ST25.

The game machine **27** receives data from the game machine control module **50** in step ST26 shown in FIG. **26**, compares data of the action target with the received serial data in the following step ST8, and determines a hit state in step ST9.

Here, if the data of the action data matches the serial data, that is, if a hit is detected, the process proceeds from step ST9 to step ST10 to display the hit action target on the screen of the monitor, to output the dynamic transmission data in step ST11, to convert it into serial data in step ST12, and to send the serial data to the game machine control module **50** as a specific response signal through the serial I/O interface SIO (FIG. **24**). When the dynamic transmission data is detected by the microcomputer of the game machine control module **50** as described in conjunction with steps ST1, ST2, and ST3 of FIG. **25**, it supplies electric power to the coils **58** and **59** of the vibrator **53** through the coil driver **64** (FIG. **24**) to vibrate the vibrator **53**. This vibration vibrates the entire game machine control module **50**.

On the other hand, if negative acknowledgement is obtained in step ST9 (FIG. **26**), it means that the data of the action target does not match the serial data from the game machine control module **50**, that is, that a hit is not detected. In this case, the central processing unit (CPU) of the game machine **27** proceeds to step ST13 to display the action target on the screen of the monitor based on the operation of the control button, and then proceeds to step ST27 to wait for data from the game machine control module **50**.

While it is arranged that the dynamic transmission data generated a hit described above is received as a specific response signal by the game machine control module **50** from the game machine **27**, the arrangement may be to send it from the game machine **27** to the game machine control module **50** via mono-directional communication.

Here, FIG. 27A particularly shows packet data PA for driving the coils **58** and **59** of the vibrator **53** among the dynamic transmission data sent from the game machine **27** to the game machine control module **50**. In this embodiment,

one packet is constituted by four current value data. Respective microcomputer of the game machine **27** and the game machine control module **50** process data in every 1/60 seconds (one frame). Accordingly, the packet data PA is also sent from the game machine **27** to the game machine control module **50** in every 1/60 seconds.

Therefore, the drive current value applied to the coils **58** and **59** of the vibrator **53** can be varied by the number of current value data in one frame interval by distributing the four current value data in one packet to one frame interval in every 1/4 frame interval.

In other words, the dynamic transmission data transferred from the game machine **27** to the game machine control module **50** in a frame interval is data processed by the microcomputer of that game machine control module **50**, whereby the packet data PA is read out. In the case of FIG. **27**A, four current value data "2", "3", "5", and "3" are read out as the packet data PA, converted into analog signals, and delivered to the coil driver **64** described in conjunction with FIG. **23**.

The coil driver **64** obtains a drive current signal SD shown in FIG. 27B by analog amplifying the values converted into analog signals with the electric power supplied from the game machine **27**. The drive current signal SD corresponds to the current value data "2", "3", "5", and "3" of the packet data PA. It becomes a current value corresponding to the first current value data "2" for the beginning 1/4 frame (time t11–t12) interval in the first frame interval FL1 (time t11–t15), a current value corresponding to the second current value data "3" for the 1/4 frame following the beginning 1/4 frame (time t12–t13), a current value corresponding to the third current value data "5" for the 1/4 frame following it (time t13–t14), and a current value corresponding to the fourth current value data "3" for the last 1/4 frame (time t14–t15) provided form the coil driver **64** to the coils **58** and **59**.

Even if the transfer timing is every 1/60 seconds for the dynamic transmission data transferred from the game machine **27** to the game machine control module **50**, it is possible to contain and transfer a plurality of current value data (four for the embodiment) in the packet for that dynamic transmission data, whereby the game machine control module **50** can distribute the plurality of current value data in one frame interval and obtain a drive current signal SD.

Consequently, the vibrator **53** is driven by the drive current signal SD that varies in a time interval shorter than the time interval (one frame interval) where the dynamic transmission data is sent. In this manner, it is possible to set the frequency of the vibrator **53** by arbitrarily varying the waveform of the drive current signal SD with a shorter time interval and various current value data, while acceleration can be set for the rotation of the motor **24** by the current value.

Incidentally, various values are set for the current value data set for the packet data PA depending on magnitude of impact applied on an action target during progress of the game in the game machine **27**. In this case, various numbers in addition to four are assigned as the number of current value data assigned to one packet. Therefore, various drive current waveforms are set according to progress of the game, whereby a high current value is alternately applied to the coils **58** and **59** for a short period of time, for example, in a scene where a high impact is applied to the action target, so that large vibration such as an impact is generated on the game machine control module **50**. On the other hand, in a scene where low and continuous vibration such as idling of a car is generated on the action target, a low current value is alternately applied to the coils **58** and **59** for a long period of time, whereby vibration as if idling of a car is generated on the game machine control module **50**.

Thus, when the response member **51** having the vibrator **53** is used, vibration similar to vibration generated on a virtual action target is generated on the game machine control module **50** according to progress of the game played on the screen, whereby the user operating the game machine control module **50** can experience the game with ambience.

While the above-mentioned second embodiment has been described for a case where the vibrator **53** reciprocates between the two magnetic members **55** and **56**, the present invention is not limited to such arrangement, but may be arranged to cause one magnetic member **71** to vibrate a vibrator **74** as shown in FIG. **28** identifying corresponding components to those of FIG. **18** with the same reference numerals.

In this case, the vibrator **74** is constituted by forming a coil **73** only on one end of a cylindrical coil bobbin **72**, and loosely fitting the coil **73** into a loose fitting hole **71E** that is formed between magnetic poles **71A** and **71B** of the magnetic member **71**. In this case, the region of the coil bobbin **72** on which the coil **73** is arranged in such a manner that, in both where the coil bobbin **72** moves to the right most position (that is, in the direction toward the magnetic member **71**), and moves to the left most position (that is, in the direction apart from the magnetic member **71**), the coil **73** exists at a position crossing the flux in the loose fitting hole **71E**.

As described, the response member **70** can be made compact as a whole by arranging the vibrator **74** to be vibrated with one magnetic member **71**.

In addition, while the second embodiment described above is described for a case where the coil bobbin **57** formed with the coils **58** and **59** (FIGS. **17** and **18**) is vibrated as the vibrator **53**, the present invention is not limited to it, but may be arranged, for example, in such a manner that the coils **58** and **59** are used as stators, and magnetic members **81** and **82** are vibrated as vibrators, as shown in FIGS. **29** and **30** designating components corresponding to those of FIGS. **17** and **18** with the same reference numerals.

That is, in FIG. **29**, the response member **75** secures coil bobbins **77A** and **77B** on support members **76A** and **76B** that are secured on the upper and/or lower cases **2** and/or **3** of the game machine control module. The coil bobbins **77A** and **77B** are formed with the coils **58** and **59** that are formed by winding conductive wires in opposite directions.

As its sectional view is shown in FIG. **30**, the magnetic members **81** and **82** have column-shaped magnetic poles **81A** and **82A** projecting from its center, and ring-shaped magnetic poles **81B** and **82B** positioned at opposite locations on the peripheral surfaces of the magnetic poles **81A** and **82A** with a predetermined interval.

The magnetic member **81** is held by loosely fitting the coil **58** into a loose fitting hole **81E** formed between the magnetic poles **81A** and **81B**, while the magnetic member **82** is held by loosely fitting the coil **59** into a loose fitting hole **82E** formed between the magnetic poles **82A** and **82B**. In addition, the magnetic members **81** and **82** are secured together by their rear surfaces, and held by a hanger **60** to be laterally movable.

Thus, similar to the above-mentioned case in conjunction with FIGS. **20A** and **20B**, the integrated magnetic members **81** and **82** can be vibrated by alternately applying drive current to the coils **58** and **59**, whereby the vibration of the

magnetic members 81 and 82 is transmitted to the entire game machine control module through support members 76A and 76B.

In addition, while the second embodiment has been described for a case where the coil bobbin 57 formed with the coils 58 and 69 (FIGS. 17 and 18) is vibrated as the vibrator 53, the present invention is not limited to it, but may be arranged to use a coil 88 as a stator and to vibrate a magnetic member 90 as a vibrator, as shown in FIG. 31.

That is, in FIG. 31, a response member 85 is constituted by a coil bobbin 87 secured between support members 86A and 86B secured on the upper and lower cases 2 and 3 of the game machine control module, and a coil 88 that is formed by winding conductive wire around the coil bobbin 67.

A disk-shaped magnetic member 90 is loosely fitted on the coil 88 with a predetermined interval, and held to be capable of rocking in the direction of arrow a and in the opposite direction by a spring 89. When the drive current is not applied to the coil 88, the magnetic member 90 is held substantially at the center of the coil 88 by the spring 89.

In this state, when the drive current I is applied to the coil 88 in a predetermined direction, as shown in FIG. 32A, a magnetic field is formed by the coil 88, whereby force F acts on the magnetic member 90, causing it to move in the right direction in FIG. 32A (direction toward the support member 86B). Consequently, the magnetic member 90 moves toward the support member 86B.

On the other hand, when the direction of the current applied to the coil 88 is reversed, force −F in a direction opposite to the case of FIG. 32A acts on the magnetic member 90, as shown in FIG. 32B. Consequently, the magnetic member 90 moves toward the support member 86A. Thus, the magnetic member 90 can be laterally vibrated by changing over the direction of current applied to the coil 88.

Thus, the vibration of the magnetic member 90 is transmitted to the entire game machine control mule through the support members 86A and 86B.

While the second embodiment of the present invention described above is arranged, as shown in FIG. 22, to contain and position the response member 51 in the first control support 4 supported by the palm of the left hand, it may be contained and positioned, as shown in FIG. 22, in at least two of spaces existing in the locations of the first and second control supports 4 and 5, and in front of the start/select section 6, or in all such spaces.

In addition, when the motors are mounted in at least two of spaces existing in the locations of the first and second control supports 4 and 5, and in front of the start/select section 6, or in all such spaces, it may be possible to mount motors or the response members 51 of the same size, or motors with different size (that is, motors generating different magnitude of vibration). Thus, when the motors with different size are mounted, they may be simultaneously or selectively vibrated, so that there is provided another advantage that the performance of the game can be further enhanced.

Furthermore, while the second embodiment has been described for a case where the game machine control module 50 is constituted by the upper and lower cases 2 and 3 made of hard resin, the present invention is not limited to it, but may be arranged in such a manner that parts of the upper and lower cases 2 and 3 are formed by resilient members, which are in turn vibrated by the response member 51, 70, 75, or 85.

That is, FIG. 33 identifies components corresponding to those of FIG. 11 with the same reference numerals, and shows an arrangement where resilient members 37A and 37B mounted on parts of the upper and lower cases 2 and 3 are vibrated by a response member 75. In the first control support 4 supported by the palm of the left hand, parts of the portion where the palm abuts are cut away, the resilient members 37A and 37B being mounted to close the cut-away parts, and deformed or expanded by relatively or partially pushing out them, whereby dynamic transmission is applied to the palm, or so-called bodily sensation of response is fed back.

Here, the resilient members 37A and 37B may be made of, for example, rubber members, resin members, or fabric members.

The response member 75 is arranged in such a manner that parts of the portions of the first control supports 4 on the upper and lower cases 2 and 3 where the palm abuts are cut away, the resilient members 37A and 37B being mounted to close the cut-away parts. Then, the response member 75 is held therein by a hanger 60, as shown in FIGS. 34 and 35, so that it can vertically moves a vibrator (magnetic members 81 and 82).

In this case, a coil 58 of the response member 75 is secured on the resilient member 37B of the lower case 3 together with its coil bobbin 77A (FIG. 30). A coil 59 is secured on the resilient member 37A of the upper case 2 together with its coil bobbin 77B (FIG. 30). In addition, a column-shaped magnetic pole 81A (FIG. 35) of the magnetic member 81 abuts the resilient member 37B of the lower case 3 through inside of the column-shaped coil bobbin 77A (FIG. 30) formed with the coil 58. A column-shaped magnetic pole 82A (FIGS. 34 and 35) of the magnetic pole 82 abuts the resilient member 37A of the upper case 2 through inside of the column-shaped coil bobbin 77B (FIG. 30) formed with the coil 59.

Therefore, in this state, when drive current is alternately applied to the coils 58 and 59, the vibrator (magnetic members 81 and 82) vertically vibrates, so that the resilient members 37B and 37A are expanded and contracted by the respective magnetic poles 81A and 82A. Consequently, the resilient members 37A and 37B are outwardly deformed or expanded above and below the portions of the first control support 4 where the palm abuts, whereby ambience to the user can be enhanced by the feel and feedback function to the dynamic transmission on the palm.

While the second embodiment has been described for a case where the game machine control module 50 is constituted by the upper and lower cases 2 and 3 made of hard resin, the present invention is not limited to it, but may be arranged in such a manner that parts of the first control support 4 that the user supports with his or her palm of the left hand are formed by resilient members, which are in turn vibrated by the response member 51, 70, 75, or 85.

That is, FIGS. 36 and 37 identify components corresponding to those of FIGS. 14 and 15 with the same reference numerals, and show an arrangement where a resilient member 42 provided at a part of the control support 4 is vibrated by a response member 75. The response member 75 is held therein by a hanger 60.

In FIG. 37, a support member 76A is secured on the upper or lower case 2 or 3. Secured on the support member 76A are the hanger 60 and a coil bobbin 77B (FIG. 30) formed with a coil 59. In addition, a coil bobbin 77A (FIG. 30) formed with a coil 58 is secured inside the resilient member 42. A magnetic pole 81A of a magnetic member 81 abuts the resilient member 42 through inside of the coil bobbin 77A.

Therefore, when drive current is alternately applied to the coils 58 and 59, the magnetic members 81 and 82 are

vibrated in the direction of arrow a and the opposite direction, so that the magnetic pole **81A** of the magnetic members **81** deforms or expands the resilient member **42** outward. Thus, the dynamic transmission is transmitted to the user as bodily sensation through the palm abutting the resilient member **42**, whereby ambience to the user can be enhanced.

While the second embodiment shown in FIGS. **33** and **37** is arranged to contain and position the response member **82** of the present invention in the first control support **4** supported by the palm, it may be contained and positioned, as shown in FIG. **5**, in the second control support **5** supported by the palm of the right hand.

In addition, while the second embodiment shown in FIGS. **33** and **37** is arranged to contain and position the motor **24** of the response member **21** in the first control support **4** supported by the palm of the left hand, it may be contained and positioned, as shown in FIG. **5**, in both the first and second control supports **4** and **5**.

Furthermore, when the motors are positioned in both the first and second control supports **4** and **5**, it may be possible to mount motors or the response s of the same size, or motors with different size (that is, motors generating different magnitude of vibration). Thus, when the motors with different size are mounted, they may be simultaneously or selectively vibrated, so that there is provided another advantage that the performance of the game can be further enhanced.

While the second embodiment has been described for a case where the vibrator is linearly vibrated, the present invention is not limited to it, but may use a vibrating method where the vibrator reciprocates along a predetermined curve.

In addition, while the second embodiment has been described for a case where the vibrator is hanged by the leaf spring **62**, the present invention is not limited to it, but may use various other hanger means such as a coil spring. In this case, the number of hanger means is not limited to one, but the vibrator may be hanged at a plurality of positions by using a number of hanger means.

Furthermore, while the second embodiment has been described for a case where a current value at each timing of drive current applied to each coil of the response member **51** (or, **70**, **75**, or **85**) is transferred to the game machine control module **50** of the game machine **27** as packet data, the present invention is not limited to it, but may be arranged in such a manner that data representing shapes of drive current waveforms are transferred from the game machine **27** to the game machine control module **50**, which in turn generates current waveforms according to the waveform data.

(3) Third Embodiment

FIG. **38** identifies components corresponding to those in FIG. **2** with the same reference numerals, and shows a third embodiment of the game machine control module according to the present invention, wherein a response member **130** is substantially horizontally mounted on a response member positioning section **133** formed in the first control support **4** of the lower case **3**, and an angular velocity sensor (gyroscope sensor) **155** for the game machine control module **120** is provided substantially at the center region of the lower case **3**.

The response member **130** has, as shown in FIG. **39**, a vibrator member **140** that is rockably hanged by a plurality of coil springs **151A**–**151H** in a substantially cubic casing **131** with six sides.

As shown in FIG. **40** that identifies components corresponding to those in FIG. **39** with the same reference numerals, the vibrator member **140** has X-axis vibrators **141A** and **141B** vibrating in the X-axis direction, Y-axis vibrators **141C** and **141D** vibrating in the Y-axis direction, and Z-axis vibrators **141E** and **141F** vibrating in the Z-axis direction. The vibrators **141A**–**141F** are secured at the center of the vibrator member **140**, and integrated as a whole.

The X-axis vibrators **141A** and **141B** are formed with coils **143A** and **143B** by winding conductive wires in the same direction around cores, respectively. Therefore, when drive current I is supplied to the coils **143A** and **143B**, magnetic fields Ha and Hb are generated in the direction corresponding to that of the drive current I.

At the moment, the X-axis vibrator **141A** receives attraction from a magnet **132A** on the casing **131** (FIG. **39**) opposite to the end of the X-axis vibrator **141A**, and moves in a direction closing to the magnet **132A**. On the other hand, the X-axis vibrator **141B** receives repulsion from a magnet **132B** on the casing **131** (FIG. **39**) opposite to the end of the X-axis vibrator **141B**, and moves in a direction separating from the magnet **132B**. Consequently, the vibrator member **140** integrated with the X-axis vibrators **141A** and **141B** is moves as a whole in the same direction as these vibrators (positive direction of X-axis).

On the other hand, when drive circuit (–I) is supplied to the coils **143A** and **143B** of the X-axis vibrator **141A** and **141B** in the opposite direction to the drive current I, magnetic fields –Ha and –Hb are generated in the direction corresponding to the drive current –I.

At the moment, the X-axis vibrator **141A** receives repulsion from the magnet **132A**, and moves in a direction separating from the magnet **132A**. On the other hand, the X-axis vibrator **141B** receives attraction from the magnet **132B**, and moves in a direction closing to the magnet **132B**. Consequently, the vibrator member **140** integrated with the X-axis vibrators **141A** and **141B** moves as a whole in the direction same as the X-axis vibrators **141A** and **141B** (negative direction of X-axis).

Thus, the vibrator member **140** as a whole oscillates between the magnets **132A** and **132B** in the X-axis direction by changing the direction of the drive current I supplied to the X-axis vibrators **141A** and **141B** in a short period of time.

Similarly, on the Y-axis vibrators **141C** and **141D**, by supplying drive current to coils **143C** and **143D** wound around the Y-axis vibrators **141C** and **141D**, respectively, while changing its direction, the Y-axis vibrators **141C** and **141D** oscillate in the Y-axis direction between magnets **132C** and **132D** of the casing **131** (FIG. **39**) opposite to the ends of these vibratos. Consequently, the vibrator member **140** integrated with the Y-axis vibrators **141C** and **141D** vibrates as a whole in the direction same as the Y-axis vibrators **141C** and **141D** (direction of Y-axis).

Furthermore, similarly, on the Z-axis vibrators **141E** and **141F**, by supplying drive current to coils **143E** and **143F** wound around the Z-axis vibrators **141E** and **141F**, respectively, while changing its direction, the Z-axis vibrators **141E** and **141F** oscillate in the Z-axis direction between magnets **132E** and **132F** of the casing **131** (FIG. **39**) opposite to the ends of these vibrators. Consequently, the vibrator member **140** integrated with the Z-axis vibrators **141E** and **141F** vibrates as a whole in the direction same as the Z-axis vibrators **141E** and **141F** (direction of Z-axis).

Incidentally, when the cycle of the drive current I is changed, the oscillating frequency can be varied for the vibrator member **140**, while, when the current value of I is changed, the force F (or, acceleration) acting on the vibrator member **140** can be changed.

Thus, when the vibrator member **140** is vibrated by supplying the drive current I to the coils **143A**–**143F** cor-

responding to the respective axes, the vibration is transmitted to the first control support 4 through a response member positioning section 133 (FIG. 38) as shown in FIG. 41. The vibration transmitted to the first control support 4 is transmitted to not only the first control support 4 but also the casings of the upper and lower cases 2 and 3, so that the entire module is vibrated. In this manner, it is possible to arbitrarily vary the states of vibration generated by the vibrator member 140 such as direction, amplitude and acceleration with the drive current I applied to the respective coils 143A–143F mounted on the vibrator member 140 of the response member 130.

Incidentally, a space in which the response member 130 may be mounted are in the first or second control support 4 or 5 supported by the palm, as shown in FIG. 42. In addition, it may be possible to utilize a region substantially at the center or the game machine control module 120 between the first and second control supports 4 and 5, the region being formed to have a large space, as shown in FIG. 43.

In this manner, as the response member 130 is mounted, for example, in the portion of the first control support 4 of the lower case 3 that is supported by the palm, in playing a game by connecting the game machine control module 120 and the game machine 27 to a monitor 33 of a TV receiver or the like, the entire game machine control module 120 can be vibrated for a predetermined period of time by drivingly rotating the vibrator member 140 of the response member 130 in response to a specific signal from the game machine 27 depending on the type of a game, for example, when the opponent is defeated in a grappling game, a target is shot in a shooting game, or an action target is an air plane and attacked on the screen, as shown in FIG. 44.

Thus, the game machine control module 120 itself vibrates through operation of the control button by the user to feed back it as bodily sensation to the user, so that ambience can be further improved.

Here, the game machine 27 contains, as shown in FIG. 44, a drive for a CD-ROM as a video recording medium, and has a lid member 28 on the top thereof for accepting and closing the CD-ROM. It further comprises a closing switch 29 for opening and closing the lid member 28, a power switch 30 for supplying electric power, a reset switch 31 for initializing the operation of the game machine 27, and a connection section 32 capable of connecting two sets of the control modules. When the connector 20 of the game machine control module 120 is connected to the connection section 32, bidirectional communication can be established with the game machine 27. While the embodiment is described for an arrangement where one set of the game machine control module 120 is connected, when two sets of the game machine control modules are connected, the operation and arrangement of the other control module are same, the description of which is omitted.

In order to vibrate the entire game machine control module 120 by driving the vibrator member of the response member 130 as described above, it is necessary to provide a function allowing bidirectional communication between the game machine control mule 120 and the game machine 27. As shown in FIG. 45, the bidirectional communication function can be accomplished by connecting the connector 20 for bidirectional serial communication with the game machine control module 120 to the game machine 27.

An arrangement attaining the bidirectional communication function on the game machine control module 120 comprises a serial I/O interface SIO performing serial communication with the game machine 27, a parallel I/O interface PIO for inputting control data from a plurality of control buttons, a one-chip microcomputer consisting of a CPU, a RAM and a ROM (hereinafter called a microcomputer), and a coil driver 164 for vibrating the vibrator member 140 of the response member 130.

The coils 143A and 143B of the X-axis vibrators 141A and 141B of the vibrator member 140 are vibrated by an X-axis direction drive current SDX from the coil driver 164; the coils 143C and 143D of the Y-axis vibrators 141C and 141D of the vibrator member 140 are vibrated by a Y-axis direction drive current SDY; and the coils 143E and 143F of the Z-axis vibrators 141E and 141F of the vibrator member 140 are vibrated by a Z-axis direction drive current SDZ.

The game machine 27 is provided with a serial I/O interface SIO for performing serial communication with the game machine control module 120. When the connector 20 of game machine control module 120 is connected, the serial I/O interface SIO is connected to the serial I/O interface SIO on the game machine control module 120 through the connector 20, whereby bidirectional communication or bidirectional serial communication can be established. Other detailed arrangement of the game machine 27 is omitted.

Signal and control lines for establishing the bidirectional serial communication include a signal line TXD (Transmit X' for Data) for data transmission for sending data from the game machine 27 to the game machine control module 120, a signal line RXD (Received X' for Data) for data transmission for sending data from the game machine control module 120 to the game machine 27, a signal line SCK (Serial Clock) for serial synchronization clock for extracting data from the respective data transmission signal lines TXD and RXD, a control line DTR (Data Terminal Ready) for establishing and interrupting communication of the game machine control module 120 as a terminal, and a control line DSR (Data Set Ready) for flow control for transferring a large amount of data.

In addition, a cable consisting of the signal and control lines for performing the bidirectional communication includes, as shown in FIG. 45, a power supply cable 35 directly led out from the power supply of the game machine 27 in addition to the signal and control lines. The power supply cable 35 is connected to the coil driver 164 on the game machine control module 120 to supply the electric power for rotating the vibrator member 140.

Here, as described in conjunction with FIG. 38, the game machine control module 120 is provided with the angular velocity sensor 155 for detecting rotation angular velocity around respective axes of rotation (X-, Y-, and Z-axes) of the game machine control module 120. The angular velocity sensor 155 has an X-axis angular velocity sensor 155A for detecting rotation angular velocity around the X-axis, a Y-axis angular velocity sensor 155B for detecting rotation angular velocity around the Y-axis, and a Z-axis angular velocity sensor 155C for detecting rotation angular velocity around the Z-axis. Thus, it detects rotation angular velocity components around the respective axes (X-, Y-, and Z-axes) according to change of angle of the game machine control module 120.

FIG. 46 shows the arrangement of a gyroscope sensor 156 of piezoelectric vibrator type constituting the Z-axis angular velocity sensor 155C. It is formed by positioning an equilateral triangle pole-shaped member 156D made of Elinvar, constant resiliency metal material, with the center line aligned to the Z-axis direction. Piezoelectric ceramic elements 156A, 156B, and 156C are adhered on the surface of Elinvar member 156. A motion component around the Z-axis is determined for the game machine control module 120 on which the gyroscope sensor 156 secured by detecting

the Coriolis force of the Elinvar member **156D**, and converting its vibration into vibration torque equal to frequency of a tuning fork, thereby the rotation angular velocity component around the Z-axis being determined as variation of voltage.

Incidentally, the X-axis and Y-axis angular velocity sensors **155A** and **155B** are also provided with gyroscope sensors with the same configuration as that of the gyroscope sensor **156** shown in FIG. **46** to align the X- and Y-axes, respectively.

Here, FIG. **47** shows the arrangement of the Z-axis angular velocity sensor **155C** including the gyroscope sensor **156**, in which an oscillator circuit **155E** oscillates the piezoelectric ceramic element **156A** for excitation by sending an oscillation signal **S156A** thereto. When there is no rotation, oscillation of the excitation piezoelectric ceramic element **156A** reaches other two piezoelectric elements **156B** and **156C** at the same time. Then, these two piezoelectric elements **156B** and **156C** send to a differential amplifier circuit **156F** oscillation detection signals **S156B** and **S156C** with the same amplitude in phase matched to that from a phase correction circuit **156G**.

At the moment, the differential amplifier circuit **156F** outputs a differentially amplified output signal **S156F** at a signal level of substantially zero, so that a direct current amplifier circuit **156I** outputs an angular velocity detection signal **S155Z** at a voltage value of substantially zero volt accordingly.

On the other hand, when the game machine control module **120** is moved, distortion is caused on the gyroscope sensor (Elinvar member **156D**) of the Z-axis angular velocity sensor **155C** according to the rotational component of the movement around the Z-axis. Then, the two piezoelectric ceramic elements **156B** and **156C** outputs oscillation detection signals **S156B** and **S156C** with different values.

This causes the differential amplifier circuit **156F** to output a differentially amplified signal **S156F** at a signal level corresponding to difference of amplification to a detector circuit **156H**. The detector circuit **156H** detects components of the differentially amplified signal **S156F** at positive signal level, and sends it to the direct current amplifier circuit **156I**.

The direct current amplifier circuit **156I** amplifies direct current components in the detection output waveform sent from the detector circuit **156H**, and outputs an angular velocity detection signal **S155Z** at a voltage level corresponding to the rotation angular velocity component around the Z-axis of the gyroscope sensor **156**. The angular velocity detection signal **S155Z** around the Z-axis thus obtained is sent to an analog/digital converter circuit **157** of FIG. **45**, and to the microcomputer after conversion to a digital signal.

Incidentally, the X- and Y-axis angular velocity sensors **155A** and **155B** has the similar arrangement to the Z-axis angular velocity sensor **155C** described above in conjunction with FIG. **47**, and output an angular velocity detection signal **S155A** corresponding to the rotation angular velocity component around the X-axis and an angular velocity detection signal **S155B** corresponding to the rotation angular velocity component around the Y-axis to the microcomputer through the analog/digital converter circuit **157**, respectively.

The microcomputer of the game machine control module **120** determines the attitude of the game machine control module **120** based on the rotation angular velocity components around the respective axes (X-, Y-, and Z-axes) obtained from such angular velocity sensor **155**. It can always generate vibration same as the dynamic transmission data specified by the game machine **27** while avoiding variation in vibration due to the dead weight of the vibrator member **140** hanged by the casing **131** (FIG. **39**) by correcting the X-axis direction drive current SDX, the Y-axis direction drive current SDY, and the Z-axis direction drive current SDZ.

In procedure for the bidirectional serial communication performed between the game machine control module **120** and the game machine **27**, the game machine **27** as shown in FIG. **45**, for example, first confirm selection data on the control line DTR to cause the game machine **27** to communicate the game machine control module **120**, and to capture control data (button information) of the control buttons of the first to fourth control sections **7**, **8**, **9**, and **10**. Then, the game machine control module **120** waits for reception of a subsequent signal from the signal line TXD. Then, the game machine **27** issues an identification code identifying the game machine control module **120** to the data transmission signal line TXD. Thus, the game machine control module **120** receives the identification code through the signal line TXD.

As the identification code identifies the game machine control module **120**, communication is started with the game machine **27** since then. That is, the game machine **27** sends control data or the like to the game machine control module **120** through the data transmission signal line TXD, whereas the game machine control module **120** sends control data from control by the control buttons or the like to the game machine **27** through the data transmission signal line RXD. In this manner, the bidirectional serial communication is performed between the game machine **27** and the game machine control module **120**. This communication is terminated when the game machine **27** outputs selection discontinue data through the control line DTR.

If such bidirectional serial communication function is provided, the game machine control module **120** can send control data mainly from the control buttons to the game machine **27**, while the game machine **27** can deliver to the game machine control module **120** dynamic transmission data for vibrating the vibrator member **140** of the response member **130**. The dynamic transmission data for vibrating the vibrator member **140** is preset by a game CD-ROM loaded on the game machine **27**, and feedback is performed by the dynamic transmission in a predetermined period of time from the game machine **27** to the game machine control module **120** itself depending on an action target of the game player.

Thus, data transmitted and received between the game machine **27** and the game machine control module **120** is transmitted by byte after packetizing into a packet consisting of 5-byte data, as shown in FIG. **48**.

In FIG. **48**, data transmitted from the game machine **27** to the game machine control module **120** through the signal line TXD has the first and second bytes containing as protocol identifiers data 0×01 and 0×42 represented by hexadecimal numbers to be transmitted, the third byte assigned with undetermined data, and the fourth and fifth bytes that are dynamic transmission data TXD1 and TXD2 to be transmitted as vibration control data for the response member **130** (vibrator member **140**) of the game machine control module **120**.

That is, as shown in FIG. **49**, the fourth data is assigned in the most significant two bits with data "01" (binary) representing a control command for the vibrator member, and in subsequent three bits vibration direction control data D_{COM} representing the vibration direction of the vibrator member **140**.

The vibration direction control data D_{COM} is data representing any one of the X-axis vibrators **141A**, **141B**, the Y-axis vibrators **141C**, **141D**, and the Z-axis vibrators **141E**, **141F** provided in correspondence to each direction of the vibrator member **140** described above in conjunction with FIG. **39**, or combination of them, and can specify seven vibration directions according to 3-bit data. Incidentally, these seven vibration directions are the X-axis direction, the Y-axis direction, the Z-axis direction, the combination of the X-axis and Y-axis directions, the combination of the X-axis and Z-axis directions, the combination of Y-axis and Z-axis directions, and the combination of all axis directions.

In addition, the data shown in FIG. **49** is appended with vibration data DX in the most significant three bits in the fourth byte, vibration data DY in the most significant three bits in the fifth byte, and vibration data DZ for the Z-axis in three bits following the vibration data DY for the Y-axis direction in addition to the vibration direction control data D_{COM} specifying the vibration direction. The vibration data DX, DY, or DZ for each axis direction is used according to any one of the vibration directions specified by the vibration direction control data D_{COM} in the fourth bytes or a combination of them.

Each of these vibration data DX, DY, and DZ represents a current value in vibrating the vibrator for each axis with 3-bit data. The microcomputer of the game machine control module **120** converts the vibration data DX, DY, and DZ into analog values. The analog signal drives the coil driver **164** (FIG. **45**), whereby drive current with a current value represented by the vibration data DX, DY, or DZ is applied to the coil of the vibrator corresponding to the axis specified by received data at the moment.

This is described in detail in conjunction with the flowcharts of FIGS. **50** and **51** identifying components corresponding to those of FIGS. **25** and **26** with the same reference numerals by referring to FIGS. **38** and **45**.

The user loads a specific game CD-ROM in the game machine **27**, sets start of the game with the start switch **11** of the game machine control module **120** shown in FIG. **38**, and sets various functions through operation of the select switch **12**, whereby the game is ready for play through operations of the first to fourth control sections **7**, **8**, **9**, and **10**.

Then, as the game is started, the microcomputer of the game machine control module **120** consisting of the CPU, the RAM and the ROM shown in FIG. **45** continuously monitors through the serial interface SIO at step **ST21** shown in FIG. **50** that dynamic transmission data for hit is sent from the game machine **27** through the serial I/O interface SIO. The dynamic transmission data contains a vibration direction and current data for the vibrator member **140** shown in FIG. **45**. Then, as the game progresses, if there is the dynamic transmission data in data sent from the game machine **27**, it drives the coil driver **164**, and supplies current supplied from the game machine **27** to the coils **143A–143F** of the vibrator member **140** as the X-axis direction drive current SDX, the Y-axis direction drive current SDY, and the Z-axis direction drive current SDZ for a predetermined period of time.

That is, after step ST1 detects the dynamic transmission data TXD1, TXD2 (FIG. 49) in the data signal received by the game machine control module **120**, the microcomputer processes the dynamic transmission data in step ST2. Here, the microcomputer previously captures in step **ST31** angular velocity detection signals S155X, S155Y, and S155Z obtained from the angular velocity sensors described above in conjunction with FIGS. **46** and **47**, determines attitude of the game machine control module **120** based on the angular velocity detection signals **S155X**, **S155Y**, and **S155Z**, and corrects the dynamic transmission data TXD1 and TXD2 based on the attitude information.

The correction is arranged to correct the drive current applied to the coils **143A–143F** of the vibrator member **140** in such a manner that the drive current has a value to generate less magnetic force in the direction to which the vibrator member **140** is attracted by the gravity, and a value to generate much magnetic force in the opposite direction.

Therefore, regardless of the game machine control module **120** at any angle to the vertical direction (attitude), the vibrator member **140** can generate appropriate vibration for the progress of game set by the CPU on the game machine **27** while avoiding variation in vibration on the vibrator member **140** due to gravity.

Steps ST22A, ST22B, and ST22C convert, among the dynamic transmission data thus corrected, data corrected on the basis of the vibration data DX, DY, and DZ representing vibration component in each axis direction in the direction (X-axis direction, Y-axis direction, or Z-axis direction, or combination of them) specified by the vibration direction control data DCOM (FIG. **49**) into analog signals, respectively. Then, in the following steps ST23A, ST23B, and ST23C, the coil driver **164** (FIG. **45**) is driven by respective analog signals. Thus, the coil drive **164** supplies the drive current I to the coils **141A–141F** of the vibrator member **140**, whereby the vibrator member **140** vibrates in the direction specified at the moment in steps ST24A, ST24B, and ST24C.

On the other hand, if data supplied to the game machine control module **120** from the game machine **27** does not contain the dynamic transmission data TXD1 and TXD2, the microcomputer of the game machine control module **120** proceeds from step **ST1** to step **ST5** in FIG. **50**, and waits for operation of the control button. If affirmative acknowledgment is obtained here, it means that the control button of the game machine control module **120** is operated. Then, the microcomputer proceeds step **ST6** to capture the control data through the parallel I/O interface PIO, and proceeds to the following step **ST31** to capture the attitude of the game machine control module **120** with the angular velocity detection signals S155X, S155Y, and S155Z from the angular velocity sensor **155**.

The angular velocity detection signals **S155X**, **S155Y**, and **S155Z** input into the microcomputer are used as correction data based on the attitude of the game machine control module **120** described above in conjunction with steps ST22A–ST24A, ST22B–ST24B, and ST22C–ST24C.

In addition, the control data input into the microcomputer is processed in step ST2 in FIG. **50**, converted into serial data in step ST7, and sent to the game machine **27** through the serial I/O interface SIO (FIG. **45**). Thereafter, the game machine control module **120** waits for data from the game machine **27** in step ST25.

Data transmitted from the game machine control module **120** to the game machine **27** assigns, as shown in FIG. **48**, an identifier for the game machine control module **120** in the upper four bits of the second byte, and data of data length/2 in the lower four bits of the second byte. In addition, it assigns an identifier (ACK) indicating that the data is response data in the third byte, and data of the button operated on the game machine control module **120** in the subsequent fourth and fifth bytes.

When such data from the game machine control module **120** is transmitted to the game machine **27**, the game machine **27** receives the data from the game machine control

module 120 in step ST26 shown in FIG. 51, compares data of an action target and the received serial data in the following step ST8, and determines a hit state in step ST9.

Here, if the data of the action data matches the serial data, that is, if a hit is detected, the process proceeds from step ST9 to step ST10 to display the hit action target on the screen of the monitor, to output the dynamic transmission data in step ST11, to convert it into serial data in step ST12, and to send the serial data to the game machine control module 120 as a specific response signal through the serial I/O interface SIO (FIG. 45). When the dynamic transmission data is detected by the microcomputer of the game machine control module 120 as described in conjunction with steps ST1, ST2, and ST3 in FIG. 50, it supplies electric power to the coils 143A–143F of the vibrator member 140 through the coil driver 164 (FIG. 45) to vibrate them. This vibration vibrates the entire game machine control module 120.

On the other hand, if negative acknowledgement is obtained in step ST9 (FIG. 51), it means that the data of the action target does not match the serial data from the game machine control module 120, that is, that a hit is not detected. In this case, the CPU proceeds to step ST13 to display the action target on the screen of the monitor based on the operation of the control button, and then proceeds to step ST27 to wait for data from the game machine control module 120.

The CPU of the game machine 27 processes data in every 1/60 seconds (one frame), and, accordingly, the dynamic transmission data TXD1 and TXD2 are also transmitted from the game machine 27 to the game machine control module 120 in every 1/60 seconds. Therefore, the drive current supplied to the coils 143A–143F of the game machine control module 120 and its direction are varied in every 1/60 seconds based on the dynamic transmission data.

Thus, when the dynamic transmission data is transmitted from the game machine 27 to the game machine control module 120, and the vibrator member 140 is vibrated to a predetermined direction based on it, the user operating the game machine control module 120 is fed back with bodily sensation corresponding to the game being developed on the monitor screen as vibration of the game machine control module 120, so that he or she can play the game with further enhanced ambience.

While the third embodiment of the present invention described above is arranged, as shown in FIG. 42, to contain and position the response member 82 of the present invention in the first control support 4 supported by the palm of the left hand, it may be contained and positioned, as shown in FIG. 42, in the second control support 5 supported by the palm of the right hand.

In addition, while the third t of the present invention described above are arranged to contain and position the response member 130 of the present invention in the first control support 4 supported by the palm of the left hand, it may be contained and positioned, as shown in FIG. 42, in both the first and second control supports 4 and 5.

Furthermore, when the response members 130 are positioned in both the first and second control supports 4 and 5, it may be possible to mount the response members of the same size, or the response members with different size (that is, the response members generating different magnitude of vibration). Thus, when the response members with different size are mounted, they may be simultaneously or selectively vibrated, so that there is provided another advantage that the performance of the game can be further enhanced.

While the third embodiment has been described for a case where the value of drive current applied to the coils 143A–143F of the vibrator member 140 is specified by the dynamic transmission data TXD1 and TXD2 transmitted from the game machine 27 to the game machine control module 120 in every 1/60 seconds, thereby changing the current value and its direction for the coils 143A–143F in every 1/60 seconds at the shortest as described above in conjunction with FIG. 49, the present invention is not limited to it, but may divide the interval of 1/60 seconds into a plurality of intervals by increasing the number of bytes of data, for example, shown in FIG. 49 to transmit the vibration data DX, DY, and DZ of respective axes in multiple times, and specify drive current values and directions for each divided interval.

With such arrangement, since it is possible to vary values and directions of the drive current applied to the coils 143A–143F of the vibrator member 140 in one frame interval by the number of vibration data DX, DY, and DZ, even if transmission timing is in every one frame (1/60 seconds) for the dynamic transmission data TXD1 and TXD1 transferred from the game machine 27 to the game machine control module 120, it is possible to apply varying drive current such as analog signals to the coils 143A–143F in a period of time shorter than the interval of one frame.

In addition, while the third embodiment has been described for a case where the current value and its direction of the drive current applied to the coils 143A–143F of the vibrator member 140 at each timing are transferred as the dynamic transmission data TXD1 and TXD2 in a packet from the game machine 27 to the game machine control module 120, the present invention is not limited to it, but may transfer data representing shapes of drive current waveforms from the game machine 27 to the game machine control module 120 to cause the game machine control module 120 to generate current waveforms corresponding to the waveform data.

Furthermore, while the third embodiment has been described for a case where the casing 131 hangs the vibrator member 140 with the coil springs 151A–151F, the present invention is not limited to it, but may use leaf springs, or float the vibrator member 140 in the casing.

Furthermore, while the third embodiment has been described for use of the vibrator member 140 having projections as the coil sections in the respective axis directions (X-, Y-, and Z-axes), the present invention is not limited to it, but may embed magnets in the respective axis directions (X-, Y-, and Z-axes) of a spherical member, and provide coil sections for the X-axis, Y-axis, and Z-axis directions at the positions of the casing corresponding to the magnets.

Furthermore, while the third embodiment has been described for a case where the vibrator member 140 integrated with the vibrators (X-axis vibrators 141A, 141B, Y-axis vibrators 141C, 141D, and Z-axis vibrator 141E, 141F) vibrating in the directions of respective axes (X-, Y-, and Z-axes) is used, the present invention is not limited to it, but may provide individual vibrators separately vibrating in each direction of axes.

In this case, for example, the response members 75 in a voice coil arrangement described above in conjunction with FIGS. 29 and 30 are individually mounted to vibrate in each of X-axis, Y-axis, and Z-axis directions, respectively, as shown in FIG. 52. With such arrangement, when the vibration data DX, DY, and DZ in the respective axis directions described above in conjunction with FIG. 49 are provided as drive current values for respective response members 75 for vibrating them, in the game machine 160, vibrations are combined for a plurality of response members 75, and vibration is generated in any directions as in the integrated

vibrato member **140** (FIG. **39**) described above in conjunction with FIG. **39**.

Even in this case, it is possible to monitor the attitude of the game machine control module **160** with the angular velocity sensor **155**, and to always generate vibration specified by the game machine **27** on the game machine control module **160** regardless of its attitude by correcting the value of drive current supplied to each response member **75**.

In addition, while the game machine control module **160** of FIG. **52** has been described for a case where the response members **75** in each of which a vibrator linearly reciprocates to generate linear vibration are arranged in respective axis directions (X-axis, Y-axis, and Z-axis directions), the present invention is not limited to it, but may provide a response member **21** with the motor **24** described above in conjunction with FIG. **3** in addition to three response members **75** arranged in the respective axis directions, as shown in FIG. **53**.

In this case, noting the fact that the response member **75** in the voice coil arrangement consumes much current, but can generate strong vibration, and that the response member **21** with the motor **24** consumes less current, but generates weak vibration, it is possible to generate vibration in various directions and with various magnitude with full ambience in accordance with progress of the game by combining and vibrating the response members **75** in the voice coil arrangement provided in the respective axis directions according to required directions of vibration when it is intended to generate strong vibration for a relatively short period of time, and by vibrating the response member **21** with the motor **24** when it is intended to generate weak vibration for a relatively long period of time. In addition, the response members **75** with higher current consumption can be driven only when it is required, so that current consumption required for vibration can be saved for the entire game machine control module **170**.

In addition, while the game machine control module **160** of FIG. **52** has been described for a case where the response members **75** in each of which a vibrator linearly reciprocates to generate vibration are arranged in respective axis directions (X-axis, Y-axis, and Z-axis directions), the present invention is not limited to it, but, for example, may replace one or two of the response members arranged in the respective axis directions with the response member **21** with the motor **24** described above in conjunction with FIG. **2**.

That is, the game machine control module **180** shown in FIG. **54** represents an arrangement in which the response member **21** with the motor **24** described above in conjunction with FIG. **3** is provided as a member for generating vibration in the two-dimensional directions in the X-Z plane, and which has the response member **21** and a response member **75** in the voice coil arrangement for generating vibration in the Y-axis direction (one-dimensional direction).

If the response members **75** and **21** are arranged in this manner, it becomes possible to have the user operating the game machine control module **180** experience strong impact (vibration) particularly in the back-and-forth direction with the response member **75**, and relatively small vibration in the horizontal and vertical directions for a long period of time.

While the game machine control module **160** of FIG. **52** has been described for a case where the response members **75** in the voice coil arrangement are arranged in the respective axis directions (X-axis, Y-axis, and Z-axis directions), the present invention is not limited to it, but may arrange two response members **21A** and **21B** having motors **24**, respectively, in place of the response member **75** in the voice coil arrangement, for example, as shown in FIG. **55**, so that their directions of vibration are in the X-Z plane and the Y-Z plane (or, X-Y plane).

The game machine control module **190** can feed back various vibrations to the user according to progress of the game by generating vibrations in two planes. Incidentally, in vibration data transmitted from the game machine **27** to the game machine control module **190** with two response members **21A** and **21B** as shown in FIG. **56**, the most significant two bits of the fourth byte are assigned with data "01" (binary) representing a control command for the driver, and the least significant three bits of the fourth byte are assigned with analog control data MA **1** representing the value of drive current applied to the first response member **21A**. In addition, the most significant three bits of the fifth byte are assigned with analog control data MA **2** representing the value of drive current applied to the second response member **21B**. Thus, when the microcomputer of the game machine control module **190** receives two analog control data MA **1** and MA **2**, it converts the analog control data MA **1** and MA **2** into analog values, and controls the coil driver with the analog signals, thereby supplying drive currents specified by the analog data MA **1** and MA **2** to the response members **21A** and **21B**, respectively.

In addition, in FIG. **56**, the least significant bit of the fifth byte is assigned with digital control data $CONT_{D1}$ indicating whether or not drive current with a predetermined value is supplied to the first response member **21A**. It is determined whether or not the drive current is supplied to the first response member **21A** by assigning "1" or "0" as the control data $CONT_{D1}$.

Similar to the above, the second least significant bit of the fifth byte is assigned with digital control data $CONT_{D2}$ indicating whether or not drive current with a predetermined value is supplied to the first response member **21B**. It is determined whether or not the drive current is supplied to the first response member **21B** by assigning "1" or "0" as the control data $CONT_{D2}$.

This is described in detail according to the flowchart of FIG. **57**. When the microcomputer of the game machine control module **190** (FIG. **55**) receives data, for example, shown in FIG. **56** from the game machine **27**, it proceeds from step ST2 of FIG. **57** to a process step based on the received data, completes reading of data in step **ST41**, and then detects the most significant two bits of the fourth byte in the following step **ST42**, thereby determining whether or not the data is control data for a game machine control module with a vibrator.

If negative acknowledgment is obtained here, it means that the received data is not control data for a game machine control module with a vibrator, or that it is not control data for the game machine control module **190** attached to the game machine **27** at the moment. In this case, the microcomputer of the game machine control module **190** returns to step **ST41** describes above, and waits for receiving of new data.

On the other hand, if affirmative acknowledgement is obtained in step **ST42**, it means that the received data is control data for the game machine control module **190** with a vibrator. In this case, the microcomputer of the game machine control module **190** determines in the following step **ST43** whether or not there exists the analog control data MA **1** for the first response member **21A** in the fourth byte of the received data.

If affirmative acknowledgment is obtained here, it represents that the analog control data MA **1** exists in the least

significant three bits of the fourth byte of the received data. In this case, the microcomputer of the game machine control module **190** proceeds to step ST**44** where it applies drive current with the value specified by the analog control data MA 1 to the motor **24** of the first response member **21**A.

On the other hand, if negative acknowledgment is obtained in step ST**43**, it represents that the analog control data MA 1 does not exist in the least significant three bits of the fourth byte of the received data (for example, the analog control data MA 1 being "0"). In this case, the microcomputer of the game machine control module **190** proceeds to step ST**45** where it reads the digital control data $CONT_{D1}$ assigned in the least significant bit of the fifth byte of the received data (FIG. **56**) for the first response member **21**A, and controls the motor **24** of the first response member **21**A to be turned on or off based on the digital control data $CONT_{D1}$.

Thereafter, the microcomputer of the game machine control module **190** proceeds to step ST **46** where it determines whether there exists the analog control data MA **2** for the second response ember **21**B in the fifth byte of the received data.

If affirmative acknowledgement is obtained here, it represents that the analog control data MA 2 exists in the most significant three bits of the fifth byte of the received data. In this case, the microcomputer of the game machine control module **190** proceeds to step ST**47** where it applies drive current with the value specified by the analog control data MA 2 to the motor **24** of the second response member **21**B.

On the other hand, if negative acknowledgment is obtained in step ST**46**, it represents that the analog control data MA 2 does not exist in the least significant three bits of the fifth byte of the received data (for example, the analog control data MA 1 being "0"). In this case, the microcomputer of the game machine control module **190** proceeds to step ST**48** where it reads the digital control data $CONT_{D2}$ assigned in the second bit from the least significant bit of the fifth byte of the received data (FIG. **56**) for the second response member **21**B, and controls the motor **24** of the second response member **21**B to be turned on or off based on the digital control data $CONT_{D2}$.

Thus, the microcomputer of the game machine **190** can perform analog control or digital control on the response members **21**A and **21**B based on the analog control data MA 1 and MA 2, or the digital control data $CONT_{D1}$ and $CONT_{D2}$ contained in the received data by repeating the process shown in FIG. **57** every time it receives data from the game machine **27**.

In this process, if the analog control data MA 1 and MA 2 exist in the received data, it is possible to apply drive current finely specified in accordance with the analog control data MA 1 and MA 2 to the respective motors **24** of the first and second response members **21**A and **21**B by preferentially using the analog control data MA 1 and MA 2.

While the microcomputer processing shown in FIG. **57** has been described for a case where, if there does not exist the analog control data MA 2 for the second response member 21B, the digital control data $CONT_{D2}$ is detected for the second response member 21B, the present invention is not limited to it, but may be arranged, for example, as shown in FIG. **58** identifying components corresponding to those in FIG. **57** with the same reference numerals, in such a manner that, if the result of determination in step ST**46** indicates that the analog control data MA 2 for the second response member **21**B does not exist in the received data, the microcomputer returns to step ST**41**, and waits for receiving of new data, instead of detecting the digital control data $CONT_{D2}$ for the second response member 21B.

With such arrangement, in a system where the digital control data $CONT_{D2}$ is not assigned for the second response member **21**B, it can be determined whether or not the second response member **21**B is analog controlled.

In addition, while the data shown in FIG. **56** has been described for a case where analog control data MA 1 and MA 2 (three bits) are assigned to the first and second response members **21**A and **21**B, respectively, the present invention is not limited to it, but may utilize some other empty regions to assign a plurality of analog control data to the first and second response members **21**A and **21**B, respectively.

With such arrangement, even if the data is delivered at a timing of every one frame (1/60 seconds), it becomes possible to vary the value of drive current applied to the response member in every interval that is one frame interval divided by the number of analog control data for one response member. This enables it to control the response member with variation of current value closer to an analog signal.

While the third embodiment has been described for a case where the microcomputer on the game machine control module **120** (FIG. **38**) determines attitude of the game machine control module **120** based on the angular velocity detection signals S155A, S155B, and S155C obtained from the angular velocity sensor **155** mounted on the game machine control module **120**, and corrects vibration of the vibrator member **140** based on the attitude, the present invention is not limited to it, but may once transmit the angular velocity detection signals S155A, S155B, and S155C from the angular velocity sensor **155** to the game machine **27**, and determine the attitude of the game machine control module **120** with the microcomputer (CPU) on the game machine **27**, thereby previously correcting the vibration data DX, DY, and DZ in the control data (FIG. **56**) to be transmitted to the game machine control module **120** before they are transmitted from the game machine **27**.

In addition, while the third embodiment has been described for a case where the value of drive current applied to the coils **143**A–**143**F of the vibrator member **140** is corrected on the basis of the angular velocity detection signals S155A, S155B, and S155C obtained from the angular velocity sensor **155** mounted on the game machine control module **120**, the present invention is not limited to it, but may determine the attitude of the game machine control module **120** based on the angular velocity detection signals S155A, S155B, and S155C obtained from the angular velocity sensor **155** mounted on the game machine control module **120**, and transmit the variation of attitude to the game machine **27** in place of input from the control button.

With such arrangement, the user can, for example, to input a command for moving an action target on the monitor screen to any desired direction only by varying the attitude of the game machine control module **120** without operating the control button on the game machine control module **120**.

Other Embodiments

While the first, second and fourth embodiments have been described for a case where electric power is supplied from the game machine **27** for driving the response member **21** (**51**, **70**, **75**, **85**, **130**), the present invention is not limited to it, but may provide a power supply for driving the response member **21** (**51**, **70**, **75**, **85**, **130**) on the game machine control module **1** (**50**, **120**, **160**, **170**, **180**, **190**), as shown in FIG. **59**.

In this case, as shown in FIG. **59**, it is sufficient to mount the power supply **95** at a position not interfering with the operation of the game machine control module **1** (**50**, **120**,

160, 170, 180, 190), for example, at a position close to the connector 20 for connection with the game machine 27, and to install a removable battery, for example, a dry cell 96 therein. With such arrangement, there is no need to supply electric power from the game machine 27, so that the game machine 27 can have a construction similar to the prior art, and it is only sufficient to replace the cable.

While the first, second and third embodiments have been described for a case where ambience is provided for the user by vibrating the game machine control module 1 (50, 120, 160, 170, 180, 190), the present invention is not limited to it, but may generate particularly very low sound by mounting a sound generator 101 in a space in the front portion of the constricted start/select section 6 of a game machine control module 100, in a space in the first control support 4 supported by the palm of the left hand, or in a space in the second control support 5 supported by the palm of the right hand, as shown in FIG. 60.

With such arrangement, feedback from the game machine 27 can be perceived as sound at hand, and can generate vibration as well if it is arranged to generate very low sound, so that ambience can be enhanced with sound and vibration.

While the first, second, and third embodiments have been described for a case where the game machine control module 1 (50, 120, 160, 170, 180, 190) is vibrated to provide the user with ambience, the present invention is not limited to it, but may provide a light emitting member, for example, an LED 106 as the response member on the upper front portion of the constricted start/select section 6 of a game machine control module 105, for example, as shown in FIG. 61. In this case, while FIG. 61 shows only one LED provided, the number of LED is not limited to one, but may be several LEDs arranged in an array. Alternately, the LED may be flashed.

When the light emitting member (106) is provided as the response member as above, ambience of hit can be obtained also on the game machine control module 105 as light is emitted at hand when an action target is hit.

The present invention is not limited to the embodiments described above. It is a matter of course that the present invention is essentially applied to all configurations where the control module used by the user with his or her hands is incorporated with a member causing sane response when an action target is hit. In addition, it is also a matter of course that the dynamic transmission of the above-mentioned embodiments is provided by appropriately combining sound and/or light. Furthermore, while the above-mentioned embodiments have been described for a case where the game machine control module causes same response according to a game developed on the screen of the monitor, the present invention is not limited to such arrangement, but may be applied to a game machine where the user experiences pseudo experience, for example, only with sound.

As described above, the present invention provides a response member on the control module itself that feeds back variation of an action target of a game to the user in synchronization with such variation in addition to visual and/or experiences of the variation of the action target, so that the control module itself generates, for example, vibration to provide bodily sensation on hit, thereby the user enjoys the game with more ambience.

While there has been described in connection with the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be aimed, therefore, to cover in the appended claims all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A game machine control module having a plurality of operation buttons, which is connected to a game machine body through a cable, comprising:
   - a control member for transmitting the operation data obtained by a plurality of said operation buttons to said game machine body through said cable, and for receiving the data containing a predetermined dynamic transmission data from said game machine body through said cable; and
   - a response member which is positioned at a predetermined place on said game machine control module itself and which is operated by said control member in response to said predetermined dynamic transmission data received from said game machine body to cause said response member to operate so as to enhance ambience of a user holding the game machine control module during a game.

2. The game machine control module according to claim 1, wherein
   - said response member is a vibration member.

3. The game machine control module according to claim 2, wherein:
   - said game machine control module is composed of a housing and a pair of handles diverging from each other in a direction from said housing toward a user;
   - said diverging handles are connected and supported by hand palms of said user; and
   - said vibration member is arranged at, at least, one place of the spatial position of said pair of said handles or near a center position of the housing.

4. The game machine control module according to claim 3, comprising two said vibration members, wherein
   - said two vibration members are arranged at, at least, two places of the spatial position of said pair of said handles or near a center position of the housing, and said two vibration members arranged at two places have a different size from each other.

5. The game machine control module according to claim 2, wherein
   - said vibration member comprises:
     - a motor;
     - a rotating shaft of which one side is connected to said motor; and
     - a member eccentrically mounted to the other side of said rotating shaft.

6. The game machine control module according to claim 2, wherein:
   - said predetermined dynamic transmission data has a plurality of packet data and each packet data has data representing a plurality of values of a driving electric current; and
   - said control member generates a driving electric current waveform to be supplied to said vibration member from the data representing said plurality of values of the driving electric current.

7. The game machine control module according to claim 2, wherein
   - the power supply for driving said vibration member is supplied from said game machine body itself.

8. The game machine control module according to claim 2, wherein
   - said game machine control module has a power supply member for driving said vibration member.

9. The game machine control module according to claim 8, wherein

said power supply member is a changeable battery.

10. The game machine control module according to claim 3, wherein

said control member controls the magnitude of the vibration of said vibration member based on said dynamic transmission data.

11. The game machine control module according to claim 1, wherein

said response member is a sound generating member.

12. The game machine control module according to claim 1, wherein

said response member is a light emitting member.

13. The game machine control module according to claim 3, comprising two said vibration members, wherein

said two vibration members are arranged at, at least, two places of the spatial position of said pair of said handles or near a center position of the housing, and said dynamic transmission data contains control data for controlling the vibrating action of each of said vibration members.

14. The game machine control module according to claim 2, wherein

said vibrating member comprises:

a coil; and

a magnetic material corresponding to said coil; wherein one of said coil or said magnetic material vibrates by the magnetic flux generated on said coil.

15. The game machine control module according to claim 14, wherein:

said game machine control module is composed of a housing and a pair of handles diverging from each other in a direction from said housing toward a user;

said diverging handles are connected and supported by hand palms of said user; and

said vibration member is positioned at, at least, one place of spatial position of said pair of said handles or near a center of the housing.

16. The game machine control module according to claim 15, comprising two said vibration members wherein

said two vibration members are arranged at, at least, two places of the spatial position of said pair of said handles or near a center position of the housing, and said two vibration members arranged at two places have a different size from each other.

17. The game machine control module according to claim 14, wherein:

said dynamic transmission data has a plurality of packet data and each packet data has data representing a plurality of values of a driving electric current; and

said control member generates a driving electric current waveform to be supplied to said vibration member from the data representing said values of the driving electric current.

18. The game machine control module according to claim 14, wherein

the power supply for driving said vibration member is supplied from said game machine body itself.

19. The game machine control module according to claim 14, wherein

said game machine control module has a power supply member for driving said vibration member.

20. The game machine control module according to claim 19, wherein

said power supply member is a changeable battery.

21. The game machine control module according to claim 15, wherein

said control member controls the magnitude of the vibration of said vibration member based on said dynamic transmission data.

22. The game machine control module according to claim 14, wherein

said vibration member is composed of a plurality of coils generating the magnetic flux in a plurality of directions and magnetic materials corresponding to a plurality of said coils.

23. The game machine control module according to claim 22, wherein

a plurality of said coils are unified with one another.

24. The game machine control module according to claim 14, wherein:

said module further has a detecting member for detecting the position of said module; and

said control member corrects the driving data to be supplied to said vibration member based on the detection result of said detecting member.

25. The game machine control module according to claim 15, comprising two said vibration members wherein

said two vibration members are arranged at, at least, two places of the spatial position of said pair of said handles or near a center position of the housing, and said dynamic transmission data contains data for controlling the vibrating action of each said vibration members.

26. A game machine control module having a plurality of operation buttons, which is connected to a game machine body through a cable, comprising:

a control member for transmitting the operation data obtained by a plurality of said operation buttons to said game machine body through said cable, and for receiving the data containing a predetermined dynamic transmission data, which further contains a plurality of control data, from said game machine body through said cable; and

a response member which is positioned at a predetermined place on said game machine control module itself and which is operated by said control member in response to said predetermined dynamic transmission data received from said game machine body to cause said response member to operate so as to enhance ambience of a user holding the game machine module during a game, said response member being controlled by said control member based on a plurality of said control data so as to selectively generate different actions of said response member.

27. The game machine control module according to claim 26, wherein

said response member is a vibration member, and said vibration member is controlled by said control member so as to selectively generate different vibrations based on a plurality of said control data.

28. The game machine control module according to claim 27, wherein

a plurality of said control data are, at least, a first control data for analog-vibrating said vibration member and a second control data for digital-vibrating said vibration member.

29. The game machine control module according to claim 27, wherein:

said game machine control module is composed of a housing and a pair of handles diverging from each other in a direction from said housing toward a user;

said diverging handles are connected and supported by hand palms of said user; and

said vibration member is positioned at, at least, one place of the spatial position of said pair of said handles or near a center position of the housing.

30. The game machine control module according to claim 29, comprising two said vibration members, wherein

said two vibration members are arranged at, at least, two places of the spatial position of said pair of said handles or near a center position of the housing, and said vibration members positioned at two places have a different size from each other; and

with respect to each of said vibration members, a plurality of said control data are contained in the dynamic transmission data.

31. The game machine control module according to claim 29, comprising two said vibration members, wherein

said two vibration members are arranged at, at least, two places of the spatial position of said pair of said handles or near a center position of the housing; and

with respect to each of said vibration members, a plurality of said control data are contained in the dynamic transmission data.

32. The game machine control module according to claim 29, wherein

said vibration member comprises:

a motor;

a rotating shaft of which one side is connected to said motor; and

a member eccentrically mounted to the other side of said rotating shaft.

33. The game machine control module according to claim 32, wherein

said vibrating member comprises:

a coil; and

a magnetic material corresponding to said coil; wherein one of said coil or said magnetic material vibrates by the magnetic flux generated on said coil.

34. The game machine control module according to claim 33, wherein

said game machine control module is composed of a housing and a pair of handles diverging from each other in a direction from said housing toward a user;

said diverging handles are connected and supported by hand palms of said user; and

said vibration member is arranged at, at least, one place of the spatial position of said pair of said handles or near a center position of the housing.

35. The game machine control module according to claim 34, comprising two said vibration members, wherein

said two vibration members are arranged at, at least, two places of the spatial position of said pair of said handles or near a center position of the housing, and said two vibration members positioned at two places have a different size from each other; and

with respect to each of said vibration members, a plurality of said control data are contained in the dynamic transmission data.

36. The game machine control module according to claim 34, comprising two said vibration members, wherein

said two vibration members are arranged at, at least, two places of the spatial position of said pair of said handles or near a center of the housing; and

with respect to each of said vibration members, a plurality of said control data are contained in the dynamic transmission data.

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